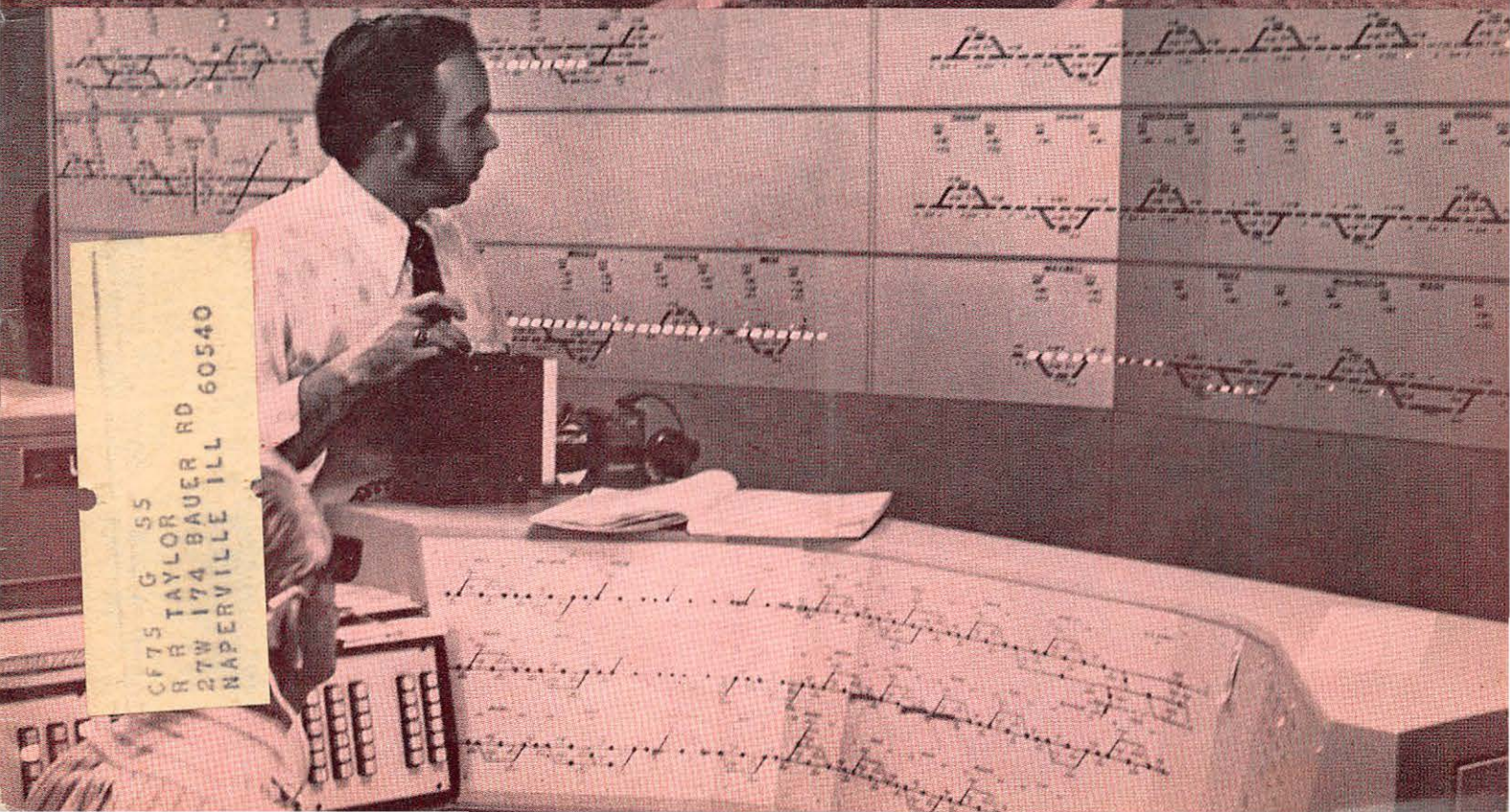
MARCH 1974

rsc

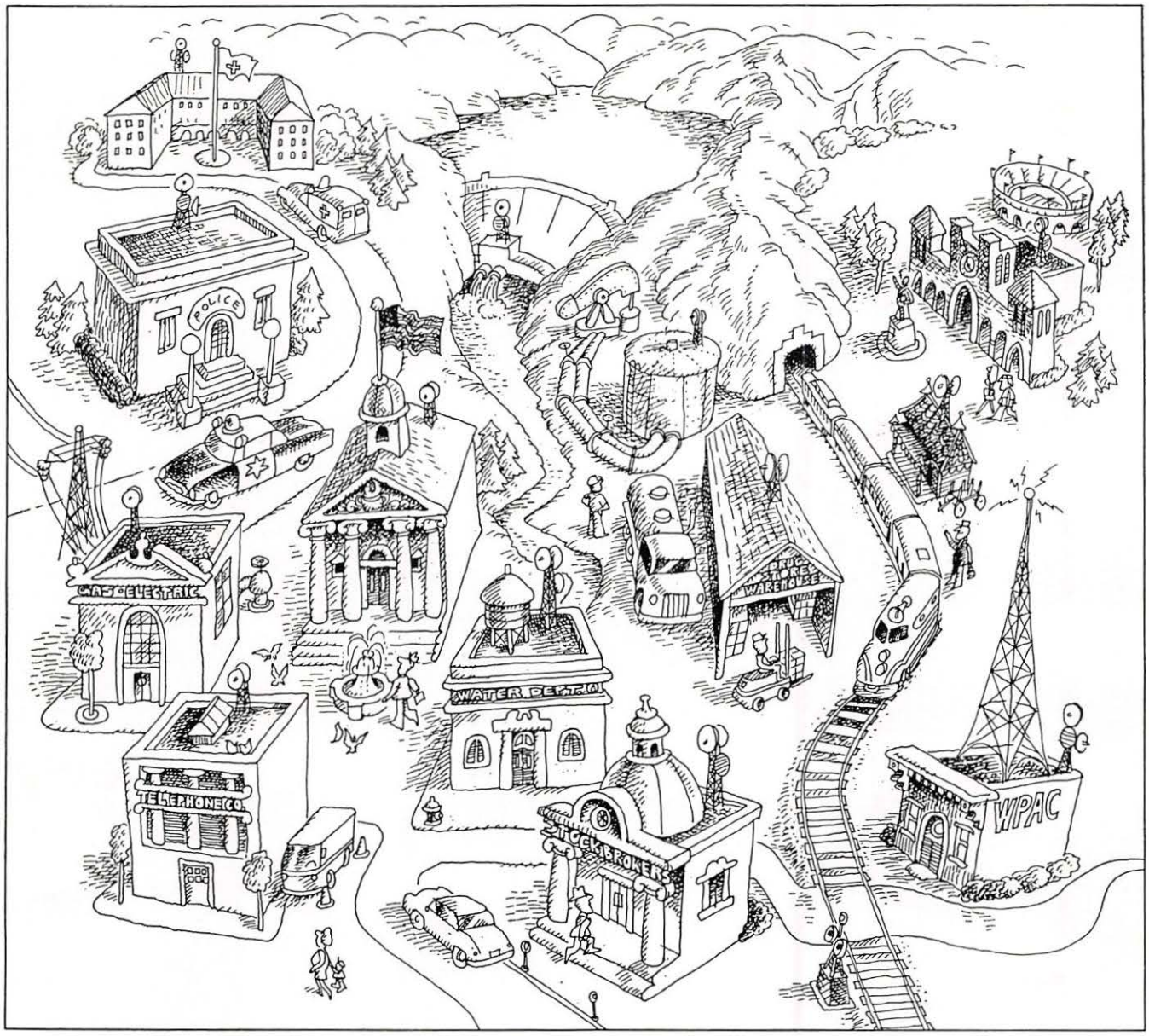
RAILWAY SYSTEM CONTROLS

"Covering All Communications, Data Processing and Signaling"

CTC: Rio Grande builds for the future



If having your own microwave communication system sounds like something out of the 21st century, take a good look at today's world.



The illustration shows some of the ways people are using private microwave systems today.

For example: railroads use microwave to monitor and control what's happening on thousands of miles of railroad track.

Medical schools use microwave to bring televised procedures from distant hospitals into the classroom.

Oil companies use microwave to control pipeline flow, and monitor production at well heads.

Utilities use microwave systems for remote supervision of energy generation plants and distribution networks.

And the list of users and potential users goes on. Through law enforcement agencies, schools and industry, highway departments, water districts, telephone companies, broadcasting companies, retail chains, stock brokers.

The point is, microwave can do a lot of things. And the opportunities for private use are just now beginning to be explored.

At GTE Lenkurt, we design, manufacture, and install complete microwave systems to handle video, voice, and data. Some are simple two-station systems. Others are enormously complex, like the 4000-mile system we put in for a railroad—one of the longest private systems in the world.

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Start by sending for our free booklet on "Microwave Applications." After you read it, you'll have a pretty good idea of what a private microwave system can do.

Maybe the 21st century has already arrived for you.

Write Microwave, GTE Lenkurt Incorporated, 1105 County Road, San Carlos, CA 94070.

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MARCH 1974 VOL. 5 NO. 3

RSC RAILWAY SYSTEM CONTROLS

"Covering All Communications, Data Processing and Signaling"

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RSC News

CN beats cold

A giant, portable, weather shelter, consisting of steel hoops covered with plastic, has been set up at Canadian National's Symington Yard. It is being used to protect signal workers while installing new retarders in the yard's hump. Temperatures inside the shelter are 25 to 30 degrees warmer than outside. Known as a "Slinky" because of its resemblance to the toy of the same name, it is 51 ft. long, 17 ft. wide and 12 ft. high.

BN orders 68 remote batch terminal systems

Burlington Northern has contracted Incoterm Corp. to supply, install, and maintain 68 Incoterm SPD 904 remote batch terminal systems for a total cost of about $1,800,000. They will interface with the Burlington Northern COMPASS data system, used by the railroad for controlling freight car movements.

The Incoterm equipment will be installed in 36 locations on Burlington Northern's routes in the Mid-West and upper Northwest. The COMPASS system allows Burlington management to obtain instant information on as many as 100,000 freight cars, including locations, contents, and destinations.

The SPD 904 consists of an intelligent keyboard/CRT with a built-in mini-computer processor, a high-speed printer, and an interpreting reader/punch. The 904's will interface with dual IBM 370/168 computers located in St. Paul, Minn.

NW expands CTC and microwave

Norfolk & Western is working on many projects for the next year. Installation of centralized traffic control between Roanoke and Pine Hall, N.C., near Winston-Salem, has already gotten under way and will be completed by the end of the year. It will provide for more efficient and safer train operation and expedite the movement of solid coal trains to Duke Power Co.'s Belews Creek plant when it opens next year.

Work has already started on a planned $13 million communication network, including a 2,400-mile microwave system. Development of the section between Roanoke and Cleveland regional headquarters will start later this year. When completed in 1976, it will provide a closer communications link between all areas of operation and the company's expanding computer system.

Cracked wheels found "in motion"

A cracked wheel detector has been developed by Wheel Checkers, of Denver, Colo. The company began research in perfecting a successful method for detecting "hair line" cracks in wheels about three years ago. After various approaches to a system were tested, a magnetic detection system has proven to be successful. After further refinements, the detector is now capable of sensing cracks anywhere on the tread of a car wheel, while the car is traveling at a moderate speed. In a recent demonstration the sensor accurately detected and recorded 13 cracks in a bad wheel.

Signals activated on Douglas "L" Route

The final segment of cab signaling on the Douglas rapid transit branch was placed in service Jan. 14, at 9:00 a.m., affording modern signal protection for "L" riders on Chicago's West Side and in west suburban Cicero.

Douglas trains continue to the Loop via the Eisenhower Expressway median and through the Dearborn street subway to the Northwest Side in the Kennedy Expressway median. Signaling of either the cab or block signal type extends throughout the entire 18-mile length of the Douglas-Milwaukee route.

Signaling on the Douglas branch is provided by cab signals in the motorman's cab of each train. Each cab signal includes two visual indications—three-color (red, yellow, green) signals comparable to block signals and a speedometer which displays allowable speed in addition to actual speed. An audible alarm alerts the motorman to speed reductions also. The electronic system is capable of stopping any train approaching another train or if the motorman fails to adhere to the speed limit.

(Continued on page 6)

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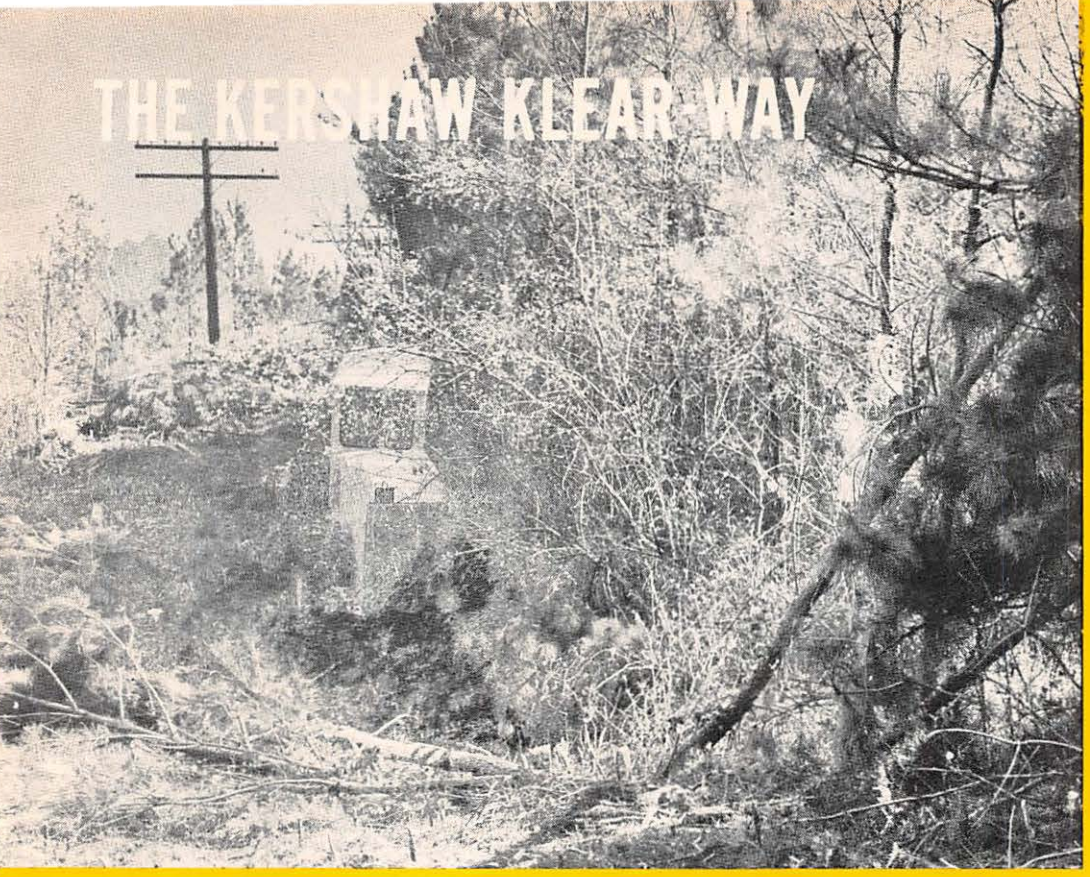

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RSC News

(continued from page 4)

The $1.1 million cost of the Douglas branch signal installation is part of a $21 million program installing a modern signal system to complete signalization of CTA's entire rapid transit system. The project is part of CTA's $140 million capital improvement program being funded two-thirds by the Urban Mass Transportation Administration of the U.S. Department of Transportation and one-third by the Illinois Department of Transportation.

"Rail Superstar" is technical conference theme

The Pittsburgh Hilton will be the site of the 1974 IEEE/ASME Joint Railroad Conference on April 3 and 4. Pennsylvania Governor Milton J. Shapp will be the luncheon speaker on April 3 and George Krambles, operating manager of the Chicago Transit Authority, will speak on April 4. The theme for the Conference is "Rail Transportation—Energy Crisis Superstar." There will be four technical sessions:

APRIL 3—9:00 a.m.

Energy, Cost and Design Criteria for Amtrak and High-Speed Passenger Trains by R. Rice, Carnegie Mellon University.

The Railroad's Position in Very High Speed Ground Transportation Developments by M. Tessier, French National Railroads.

Possible Speed Increases on Existing Railroad Systems: The SNCF Case by H. J. Autrieffe, French National Railroads.

"Project 21" Rapid Transit System by L. K. Edwards and L. H. Donnell.

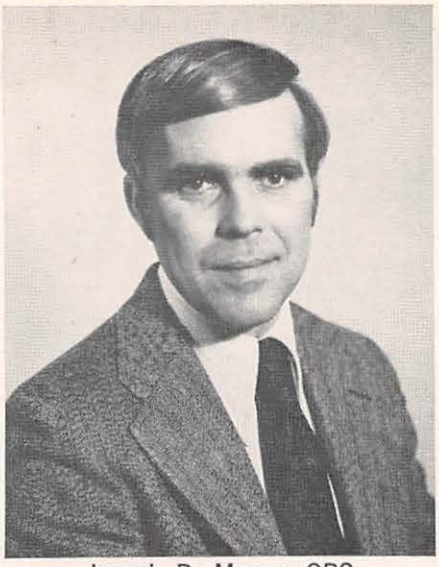
APRIL 3—2:30 p.m.

Environmental Finite Life Fatigue Testing Utilizing Miner's Hypothesis by R. M. Cook, AAR.

Development of Fatigue Standards for Freight Car Truck Components and Wheels by M. R. Johnson, IIT Research Institute.

Determination of Carbody Center Plate Fatigue Design Criteria by Full-Scale Laboratory and Field Testing of a Hopper Car by L. W. Smith, Dresser Industries.

Effects of Longitudinal Impact Forces on Freight Car Truck Bolsters by M. R. Johnson, G. Ojdrovich and R. E. Welch, IIT Research Institute.



Joseph B. Means, GRS

Stephen Ailes, AAR

APRIL 4—9:00 a.m.

Evolution of Automatic Control and Management Information Systems in Classification Yards by P. J. DeIvernois, Union Switch & Signal.

Sheffield Yard—A Distributed Control System by J. B. Means, General Railway Signal.

Southern Pacific's West Colton Yard by W. V. Williamson and R. C. Nagel, Southern Pacific and F. E. Young, Wabco.

APRIL 4—2:30 p.m.

Statistical Characterization of Railway Track Behavior by J. C. Corbin, Ensco, Inc.

Modeling and Simulating Longitudinal Train Action Forces by V. T. Hawthorne, Keystone Railway Equipment.

Truck Hunting in Freight Cars by D. Reynolds, Southern Railway.

Improvements in Design of Direct Release Valves by I. G. Moore and D. J. Wickham, Westinghouse Brake & Signal Co., Ltd.

Cybernetics symposium

The Fourth International Symposium on Railroad Cybernetics will be held on April 21-26 (from the date of registration to the date of the technical visits) at the Mayflower Hotel, 1127 Connecticut Avenue NW, Washington, D.C. The symposium has been jointly organized by the International Union of Railways, the International Railway Congress Association, and the Association of American Railroads. Stephen Ailes, president of the AAR comments: "The Symposium will make it possible to assess the accomplishments derived from the application of various computer systems and devices, clarify unresolved problems, and create opportunities for further progress in the area of freight traffic management and operations."

During the Symposium's sessions simultaneous translations will be provided in English, French, and German. The papers will be translated into those languages and distributed to the delegates before the Symposium.

Program—"Freight Traffic Management and Operations"

April 21—9:30 a.m.-5:00 p.m.—Registration of delegates; 3:00 p.m.—Meeting of Technical Committee and of Section Chairmen, Vice Chairmen, and Secretaries; 6:30 p.m.—AAR Welcoming Cocktail Party

April 22—9:30-10:30 a.m.—Official Opening Ceremony 11:00 a.m.-12:30 p.m.—Section 1: Fundamentals of Modern Freight Traffic Management 12:30-2:00 p.m.—Business Luncheon 2:00-5:30 p.m.—Section 1; Fundamentals of Modern Freight Traffic Management

April 23—9:00 a.m.-12:30 p.m.—Section 1: Fundamentals of Modern Freight Traffic Management; Section 11: Description of, and Practical Experiences in Operations and Other Fields with Existing Systems; 2:00-5:30 p.m.—Section II continued

April 24—9:00 a.m.-12:30 p.m.—Section II; Description of, and Practical Experiences in Operations and Other Fields with Existing Systems; 2:00-5:30 p.m.—Section III: Technical Aspects; 7:00 p.m.—Cocktail Party; 8:00 p.m., Banquet

April 25—9:00 a.m.-12:30 p.m.—Section III: Technical Aspects; 12:30-2:00 p.m., Business Luncheon; 2:00-5:00 p.m., Closing Plenary Session

April 26—Technical Visits (details about these visits will be sent to delegates at a later date).

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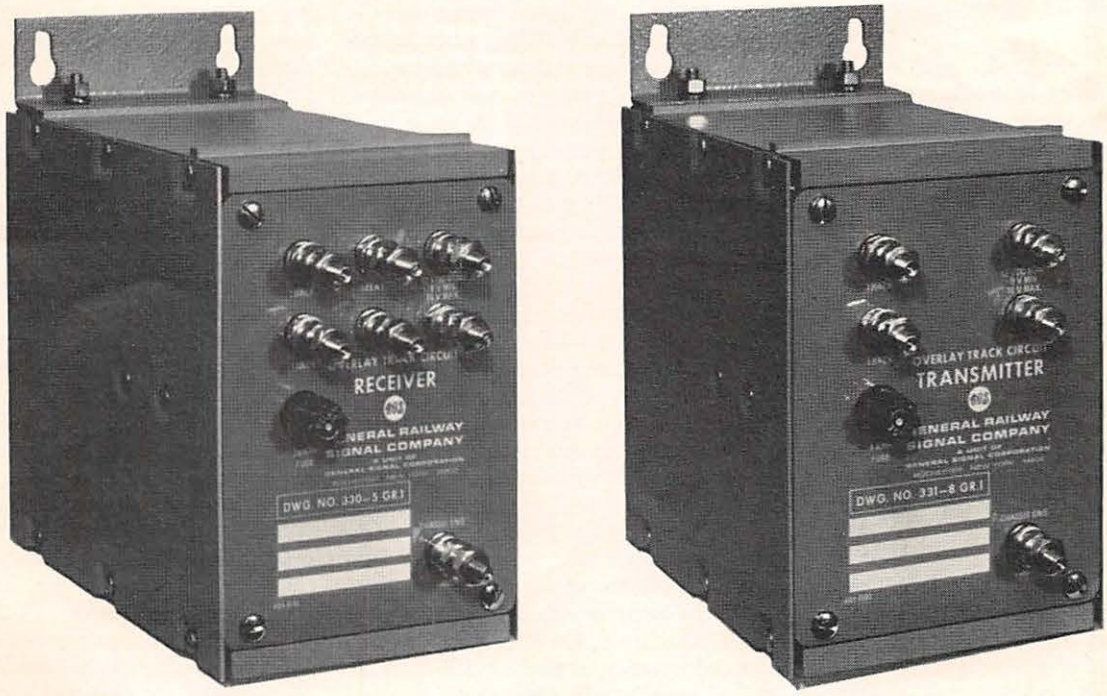

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Railroad bill would provide funds for RSC-related projects

When Congress turns its attention to railroad equipment problems, the focus is usually on rolling stock, and for a good reason: shippers want more freight cars, and more locomotives to haul them. And when big shippers talk —especially big lumber shippers in the Northwest—Congress usually listens. The result is oftentimes just another "freight-car bill." But the big piece of legislation now before Congress, the Transportation Improvement Act of 1974, is far more than a freight-car bill. The Nixon Administration, which sent the bill to Congress Feb. 13 after a White House briefing by Secretary of Transportation Claude S. Brinegar, has realized that there is more to the railroad problem than rolling stock shortages. So the present bill, in a drastic departure from earlier proposals, provides loan guarantees not only for rolling stock—but also for roadway and for related facilities, including signaling. The bill also calls for an appropriation of $35 million to develop a rolling stock control system.

The first provision of the new legislation of particular interest to the RSC field is that providing for up to $2 billion in Federal loan guarantees for railroad modernization. The bill specifies that this money should be used to finance the acquisition, construction, maintenance, or development of the following railroad facilities and equipment:

(1) track, roadbed and related structures subject to traffic usage of at least 5 million gross ton-miles per mile of road per year;

(2) electrical, communication, and power transmission systems;

(3) signals;

(4) terminal facility modernization and consolidation; and

(5) new and rebuilt rolling stock.

(Another recent Washington development that is potentially of great importance to the RSC field is that provision of the "Rail Services Reorganization Act" which directs the DOT to invest between $500 million and $700 million in Northeast Corridor passenger-line improvements. Senator Vance Hartke (D.-Ind.), a principal sponsor of this provision, has said that electrification will be an important part of the project. The DOT recently invited engineering firms to submit proposals for the extensive new studies that must be compiled before the Northeast-Corridor rehabilitation and modernization program can begin.)

Claude S. Brinegar

Explaining DOT's decision to make the loans available for non-rolling stock purposes, Secretary Brinegar recently observed that "As we dug into it, last spring and summer, I kept raising the question, "Who needs to do what?" Even Penn Central has been able to acquire freight cars, albeit at high interest rates. But it's harder to raise the money for things like investments to make it easier to move a freight car through Chicago or through St. Louis or Philadelphia."

That provision of the bill which would establish a rolling stock scheduling and control system says this:

"The Secretary is authorized to conduct research and development into the design of a national rolling stock scheduling and control system which, utilizing advanced computer and communication techniques, would be capable of locating and expediting the movement of rolling stock on a national basis. In conjunction with this task, the Secretary shall study, in cooperation with the Interstate Commerce Commission and the railroads, the information, functions, and procedures necessary to provide efficient and expeditious car service on a national basis. Within two years from the date of enactment of this section, the Secretary shall report to the Congress his recommendations respecting the organization, development, funding, and implementation of any national system which he may design as a result of research and development. In arriving at his recommendations, the Secretary shall consider—

"(1) the need for timely and accurate information regarding the location and movement of rolling stock on a nationwide basis;

"(2) the requirements and technological standards necessary to insure that the advantages to be obtained from a national system accrue to each participating railroad;

"(3) the requirements and technological standards necessary to insure the flow of car service orders from a national system to the rolling stock scheduling and control systems of an individual railroad and compliance by that railroad with the car service orders;

"(4) the uniform data and other technological requirements that must be contained in the rolling stock scheduling and control systems of an individual railroad to permit efficient linkage of its system with a national system;

"(5) the economic, safety, and service benefits to be derived from a national system; and

"The Secretary shall conduct a study respecting (1) the costs to individual railroads of installing rolling stock scheduling and control systems compatible with a national system . . . and (2) the economic, safety, and service benefits to be derived from compatible systems. Not later than two years from the date of enactment of this section, the Secretary shall announce his recommendations for the installation of the systems by individual railroads. The Secretary is authorized to provide technical assistance to railroads in the implementation of rolling stock scheduling and control systems designed in a manner consistent with his recommendations.

"(c) Within two years from the date of enactment of this section, the Secretary shall begin demonstrations to test the feasibility of, and the benefits to be derived from the installation of rolling stock scheduling and control systems (including technological innovations) in railroad yards and terminals. Any railroad engaged in the transportation of freight may submit an application to participate in a demonstration. The application shall conform to regulations issued by the Secretary and shall be judged by (1) the economic, safety, and service benefits to be derived from the programs proposed therein; and (2) the potential contribution of the program to and compatibility with any rolling stock scheduling and control system designed under . . . this section.

"(d) There is authorized to be appropriated $35,000,000 for the purpose of carrying out this section, including the payment of necessary administrative expense . . . ."

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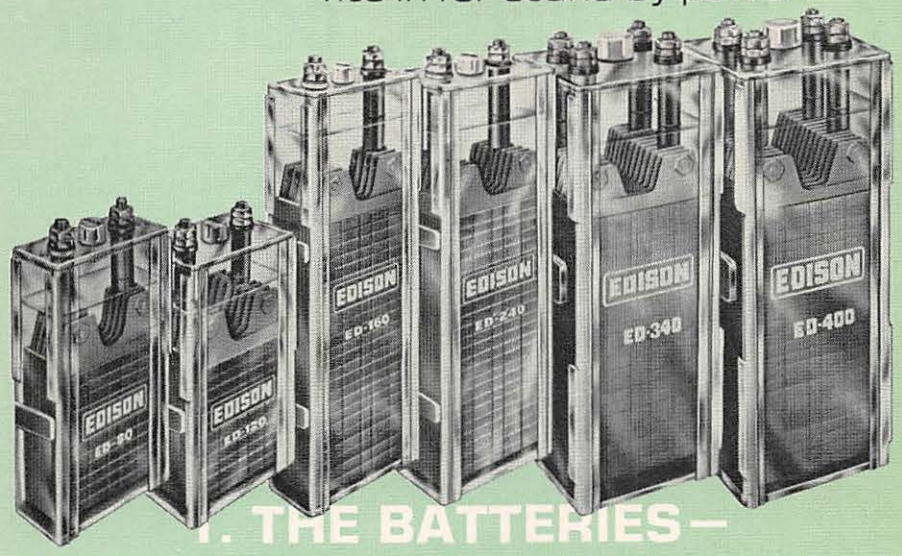

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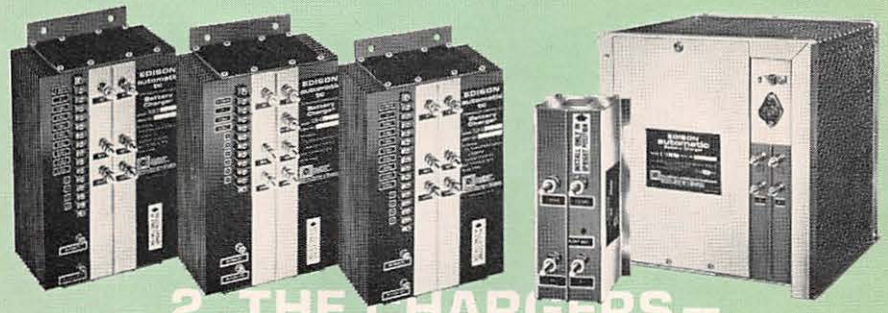

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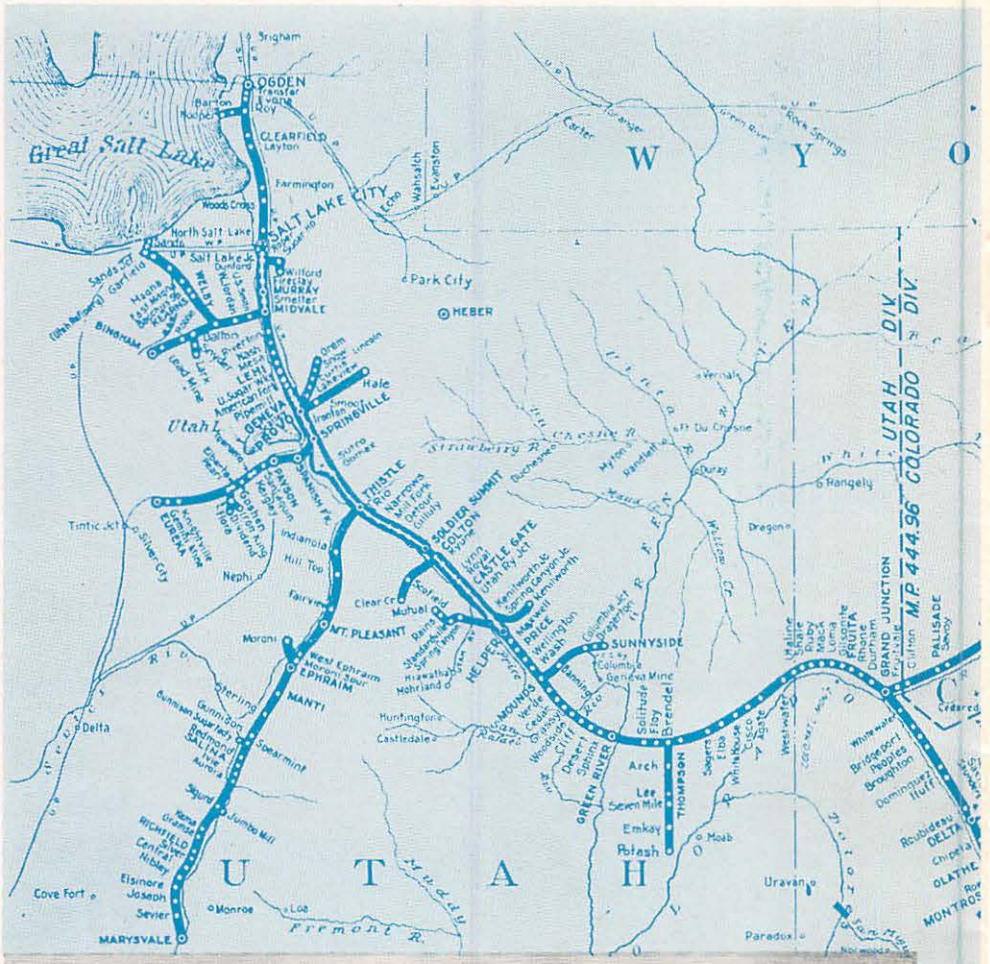
RAILWAY SYSTEM CONTROLS

D&RGW centralizes, computerizes

Centralized traffic control is not new on the Denver & Rio Grande Western. A pioneer in adapting this technology to more efficient railroad operations, Rio Grande's CTC experience dates back over 30 years. What is new on the Rio Grande is CTC that is both computerized and centralized. To get the story first hand, RSC Editor Al Klinger recently visited Rio Grande's Denver headquarters, inspected the new setup, and talked with the men who conceived, designed and implemented the system. His report on Rio Grande's centralized dispatching concept—and also on a computer switch which the designers accomplished in midstream, as it were, in the best pioneering spirit—follows.



September 1971 marked the beginning of the first planning stages for consolidation of all dispatching at one location in the Rio Grande's Denver office. At this point Rio Grande had set certain limits on the extent that a computer could be used to handle operations related to the railroad's new approach to centralized traffic control. As time went on, more applications of the computer began to reveal themselves. The advantages of these newly found applications were soon realized and room for improvement had to be made. One problem presented itself at a very inconvenient time: The computer which Rio Grande had already interfaced with its CTC system would be taxed considerably as new functions were added. After considerable effort toward adapting to the expanded requirements, the old computer was removed and work began on a computer with greater capacity and flexibility.

PLANNING

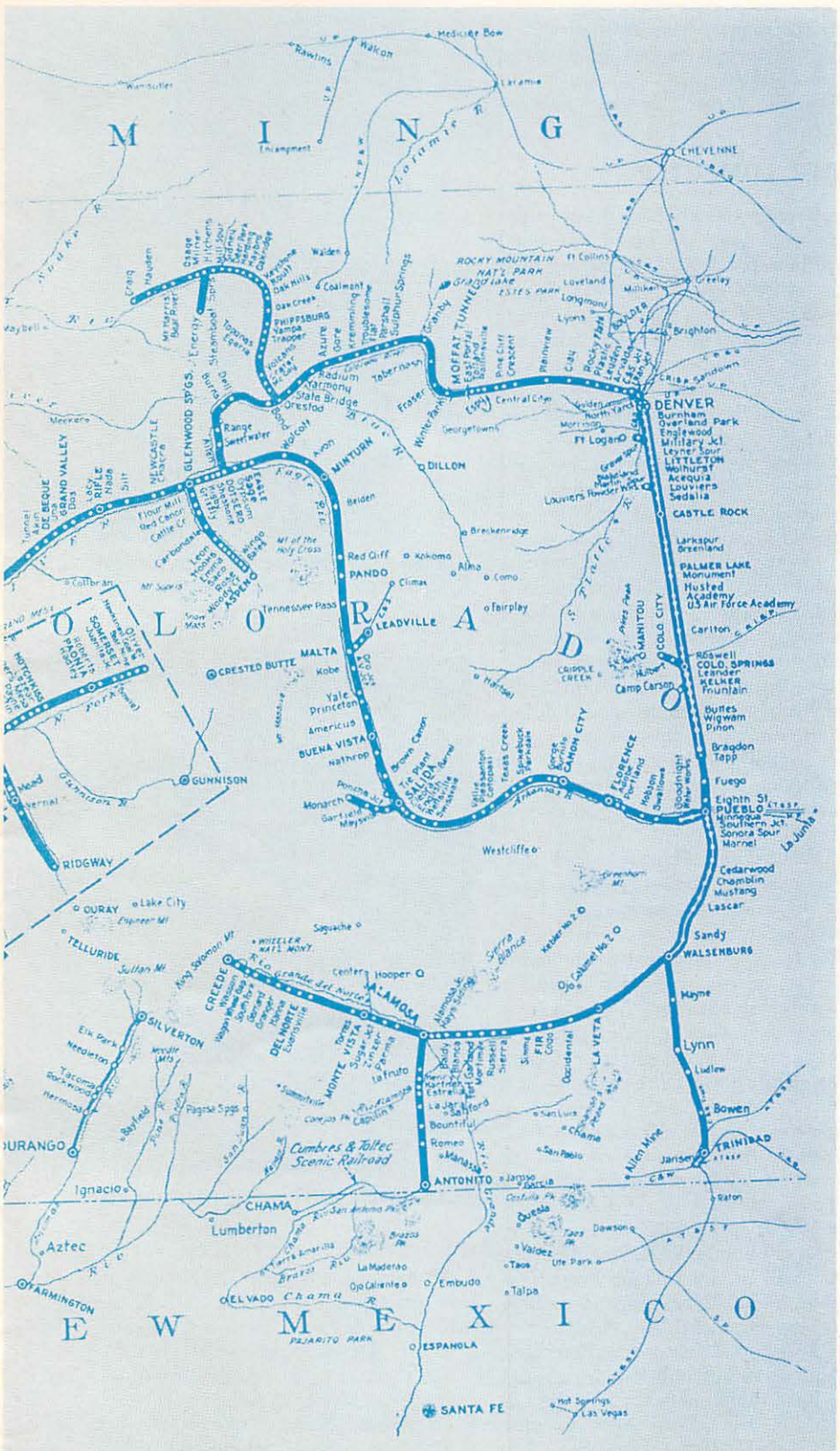
The project started off with certain requirements and functions and soon grew to incorporate additional ones. These needs were laid out as follows:

Computer Interface with Centralized Dispatching System

Equipment:

- PDP 8/E, By Digital Equipment Corp. *(Continued)*

CTC dispatcher control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Romeo
Manassa
Bountiful
Sanford
Capulin
Tafuto
Conejos
Jarosso
Garcia
San Pablo
Chama
San Luis
Allen Mine
Jarisen
LA VETA
Cuchara
Cokedale
Ludlow
Trinidad
Aguilar
Starkville
Segundo
Walsenburg
Gardner
Gulnare
Farisita
Russell
Sierra
Slims
FIR
Cobb
Occidental
Keller No 2
Keller No 2 O
Sierra Blanca
Ojos
Alamosa
Monte Vista
Torres
Sugar City
Center
Farmo
Hooper
Mosca

- ASR 35 Teletype
- Low Speed Line Printer
- 8 CRT Terminal-Dispatcher
- 4 CRT Terminal-Chiefs

Conceptual Functions

Dispatching:

- Train sheet information collected, stored, displayed and updated by Terminal or Control System
- Data retained in file over sub-district and printed in hard copy upon termination.
- Meet delays automatically recorded and some method of input to record other delay data.
- Automatic Dispatching limited to clearing (2) controlled signals in advance and alerting dispatcher for meets.
- Storage and display of all relevant data on trains, crews, and engines.
- Consolidation of CRT's on light shifts.
- Branch line records from manual inputs.

Power Inventory: (Future)

- Maintain inventory of power available, en route, and shopped.
- Power performance history (HP/Trailing tons, Miles, etc.)

Train Performance Reporting

(Future input to Data net system)

- Produce detail and summary reports of performance.
- Create statistical history data files of transportation produced (loads, empties, tons, train miles).

Timekeeping: (Future)

- Produce train records for auditing time slips.
- Explore possibility of developing cost-service data.

CONSOLIDATION

The Rio Grande has long been a "CTC" railroad, with intensive application going back to 1942. When plans for moving to its new headquarters building in Denver had gone beyond "just planning", D&RGW began research toward finding the most suitable method of centralized dispatching.

The railroad opted for a new terminal control system called NOVILOG (Non-Vital Logic) developed by Harmon Electronics. Building of the new CTC system was then started, and the first dispatching district was transferred over to the Denver office on April 17, 1973. One at a time, districts were transferred over throughout the year until finally the last section from Grand Junction, Colo., to Helper, Utah, was transferred on Dec. 23, 1973.

Without the computer, manual operation is now controlling the almost 2,000-mile railroad from the new CTC consoles in Denver.

ADVANTAGES AND SAVINGS

The approach taken has resulted in many improvements in both planning and operations. Just a few major ones are:

- Advance coordination of motive power.
- Better communications.
- Better management control.
- Advancements in maintenance and troubleshooting.
- For the future, savings in timekeeping.

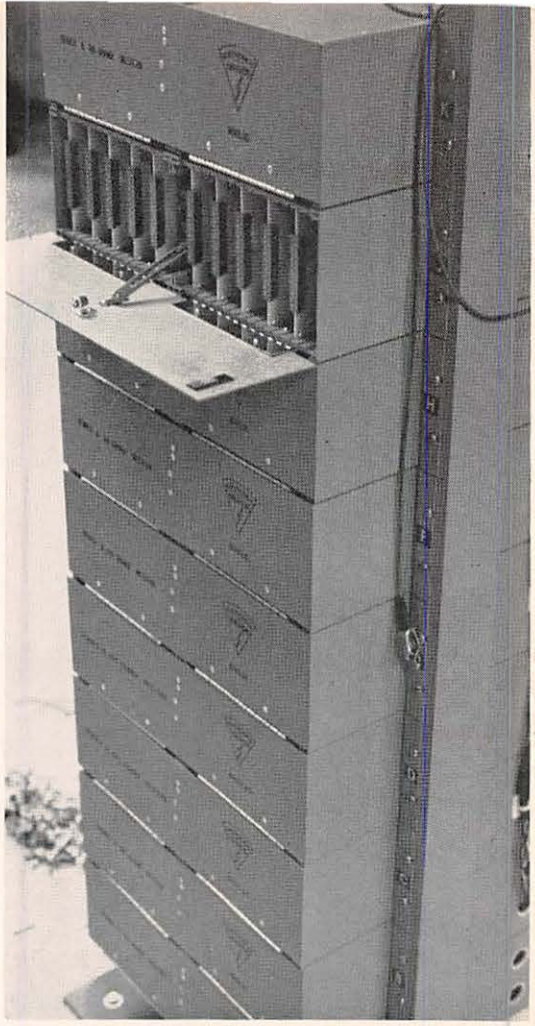
BIGGER COMPUTER

Rio Grande officers have high praise for the work that has been performed by Harmon Electronics as prime contractor, and General Railway Signal, which supplied new master code units for the system. The only problem that has so far developed has been in the computer system—and Harmon has resolved that to the satisfaction of all concerned.

The initial requirements on the computer system were fairly modest, but as the project progressed and the potential usefulness of this tool was recognized, more and more requirements were introduced. Unfortunately, the existing hardware capacity and basic programming system being developed for PDP-8 were not adequate to handle these new applications. After two of the four new consoles were in service, it became apparent that the computer system requirements had outgrown the system design, and planning was begun on a completely new, more powerful system.

At that time, Harmon and Rio Grande people together took a hard look at possible future expansions of the computer system functions to determine whether to add equipment to the existing PDP-8 system or replace it with a more powerful machine. The decision was made to replace it with a PDP-11, also made by Digital Equipment Corp., offering many times more capacity and flexibility.

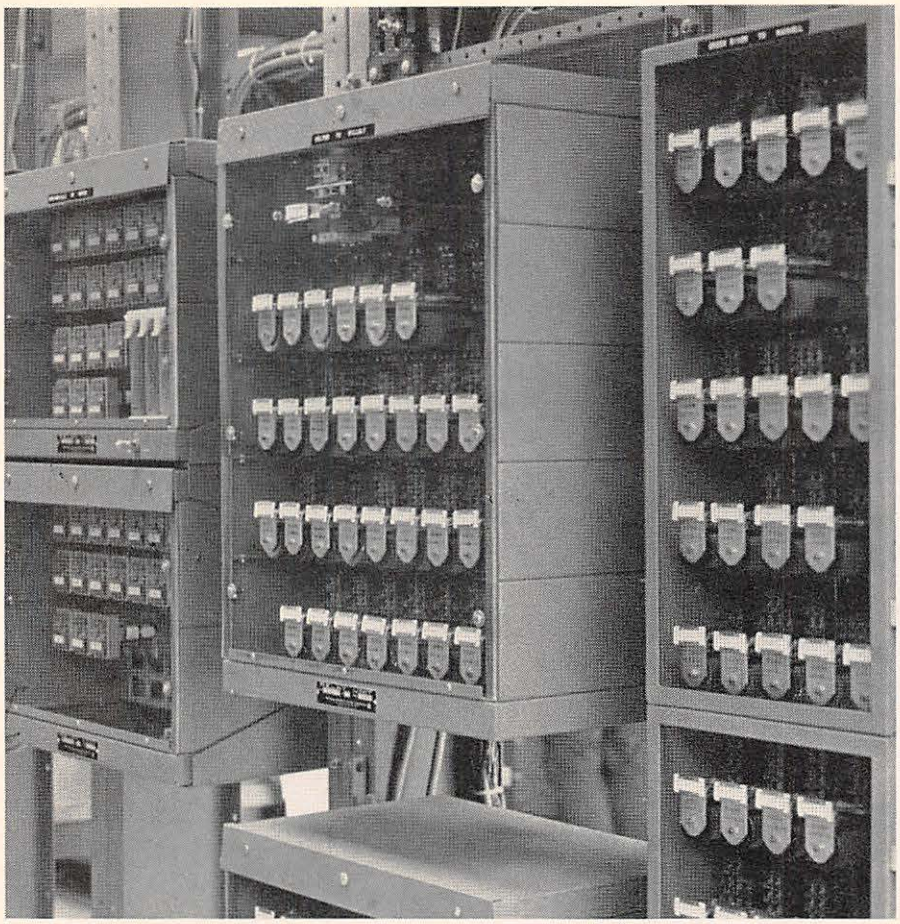
Comparison of just a few points illustrate clearly the increased capacity of the new system. It uses a 16 bit word as opposed to 12 bits on the PDP-8. The new system has 32K words of core, while the old one had 8K. And the disc capacity will be 1.2 million words (expandable to 9.6 Meg.), up from 96K with a maximum of 128K. Add to this the many internal features in handling data and servicing multiple input and output lines simultaneously, and the advantages in the changeover become clear.



INTERFACE between computer and CTC equipment is a small package.

FLASHING LIGHT on dispatchers panel

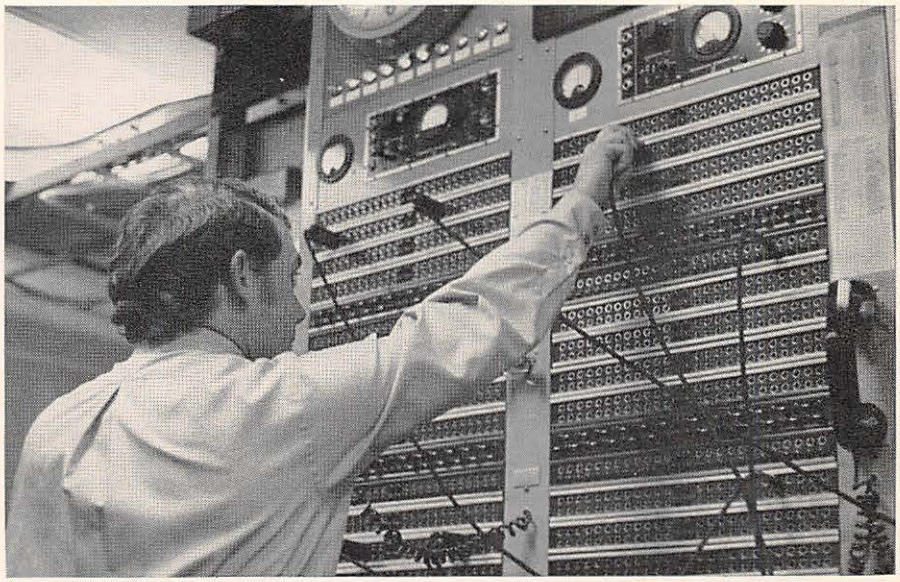
Harmon is currently developing the new programming for the PDP-11 system at the Harmon plant in Grain Valley, Mo. Development will be carried out in-plant as far as possible, using simulated data inputs in place of the actual CTC system. Delivery of the system to railroad property is anticipated in July,



NEW GRS EQUIPMENT supplies all field information needed by Harmon's equipment. CTC code units are GRS type F-K-J code system.

EASY TROUBLESHOOTING is demonstrated by R. Watkins of Harmon.

is pressed to accept incoming calls.



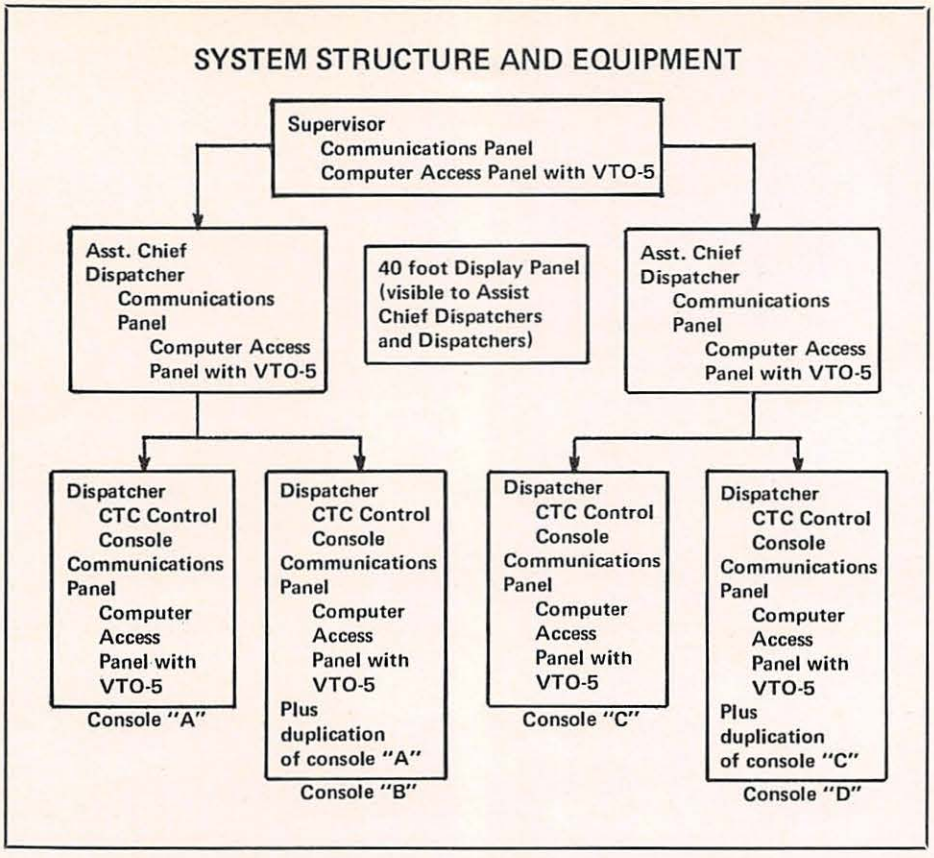
PATCH PANEL is being used by L. D. Busboom to test a circuit in doubt.

with completion targeted for August.

BACKUP

There is no plan at present to provide a backup computer for the PDP-11. Since the computer's function is record-keeping and, in effect, button-pushing for dispatcher, backup in the event of failure will consist of a return to manual recordkeeping and signal clearing. Consideration is presently being given to a magnetic tape system which, if added to the computer system, would provide a log of all data being processed into and out of the computer. This would provide a detailed record of past occurrences, protecting this data against loss.

No provision is made for operation of the computer during interruption of AC power. However, the PDP-11 does have a power-fail detector which detects a power interruption in time to go into systematic shut-down routine and



store in magnetic core all data presently being processed in volatile storage. When power returns, the program will retrieve the data and resume where it left off, the only loss being any new data that may have been received from line during the outage.

OPERATION

A maximum of seven people are needed to operate the CTC system under normal conditions, but during light traffic conditions two dispatchers plus two assistant chief dispatchers may handle the entire load. Four control consoles are manned to control the entire railroad and with light traffic load, console "A" can transfer his operation over to console "B", and console "C" can transfer his operation to console "D". When a train is progressing from one console to the next, the PDP-11 will automatically transfer the necessary data over to the next console.

Incoming CTC codes provide data from the field to be recorded by the computer. OS times at each station are displayed automatically on the dispatcher's tracking CRT when the train is in his territory. Light indications on the 40-foot display panel also show the status of the entire railroad.

A miniature track diagram is provided for each dispatcher to permit blocking of track sections and each power switch. This is done by use of normally closed jacks which are built into the track diagram. The blocking of either a switch operation or a section of track is accomplished by inserting a non-conducting plug into the jack which will open a normally closed circuit and de-energize a relay. The block is acknowledged by indication lights on the 40-foot-long, three-layer-high display panel which all the miniature track diagrams are tied into. These indication lights are lit through all the back contacts on the blocking relay and provide a good manual check on whether the block was, in fact, accomplished.

When a dispatcher wishes to establish a route, he initiates a control transmission by first coding in the location number on his push-button keyboard. At this time the location number will appear on the readout of his keyboard. After location has been established, the control code number for the function desired is sent, then the position required is entered. A flashing light indication on the main display panel verifies each control entry and finally the data is sent to the field by pressing the "start" button. Solid white lights on the routes of the 40-foot display panel indicate routes the dispatcher has lined. As a train passes through a given route, its location is indicated by red lights which go dark after it passes through the area. Size and brilliance of these lights, along with the route lighting technique used, make the panel unmistakably clear.

THE COMPUTER PLUS CTC

The PDP-11 will play an important role in operation and record keeping for the Rio Grande. All dispatchers can place information pertaining to their operation into the computer, or they can request information about any part of the whole operation. The information will be displayed on the command CRT. The chief dispatcher and assistant chief dispatchers have access to all information in the computer.

For each train moving in a dispatcher's territory, the CRT will display the train number, lead unit number, total cars in the consist, and the location and time of the last 3 OS/points. After the dispatcher feeds in the first OS, the data comes into the CTC board for the next station and is also brought into the computer. The computer then tracks the train throughout its run, regardless of meets, overtakes, backup moves, pickups and setouts.

Information gathered by the computer is used to compile a trainsheet. The PDP-11 will automatically print out a complete trainsheet of all moves on every shift. The chief dispatcher can call for a printout at any time he has need of it.

The computer will not attempt to resolve a conflict such as a meet or an overtake between two trains. It will detect when a meet or an overtake will occur, and if the dispatcher has taken no action to handle the situation, the computer will alert the dispatcher and request that he do so.

The computer outputs tie into the system so that the control outputs from the computer are subjected to all the checks that the dispatcher's movements are subjected to. The dispatcher can, however, enter a manual over-ride over the computer's control entry whenever he feels it necessary.

NOVILOG

Harmon's NOVILOG approach was to create a hybrid system using relays for particular jobs which relays can handle best, and computers for jobs which computers handle best.

Objections to relay type systems of the past had to be overcome. This system uses inexpensive miniature telephone-type relays. The relay provides split contacts for high contact reliability and is rated for more than 100 million operations at low contact load. Small size of the relay provides considerable space savings over some of the more traditional assemblies. The same basic relay is available in a number of options including different voltages and different contact forms. Several forms of magnetic latching are available to provide reduced power consumption by the overall system.

The circuitry has been divided into various functional modules or printed

circuit boards. Each PC board provides most or all the necessary circuits involved in a particular function. With a wide variety of circuit options on the modules, a maximum interchangeability among different modules can be provided.

FIELD CHANGES

The combination of GRS code equipment and the Harmon hybrid relay system enabled the system to be built without any major changes in the field. A few field stations were added to the system and some DC physical line had to be converted to carrier operation.

COMMUNICATIONS

D&RGW was a pioneer in application of a system-wide microwave network, installed in 1961. Originally, microwave was needed to fill the need of the road's Videograph and communications system. This system of transmitting facsimile was removed about three years ago. A CRT display was substituted to provide car location information over the entire system and for offline and on-line traffic offices.

Today, 420 channels are available with the Motorola MR-20. Within the next year the Rio Grande will be going solid state with a system built by Lenkurt.

The dispatcher's phone lines have been broken into sections 50 miles long, with each section brought into the dispatcher's console separately. This has been done to discourage unnecessary and distracting crosstalk between sections. When a call comes in from a section, a pushbutton flashes on the dispatcher's console. The dispatcher presses the button to talk to that section.

Radio communications are isolated to separate operating territories. Again, by isolating radio transmission to a relatively small area a great deal of annoying crosstalk is eliminated. When a mobile radio operator calls in, he automatically makes contact with the dispatcher handling his section of the railroad.

FUTURE ADDITIONS

Eventually D&RGW may use a magnetic tape drive for storing all information for later transfer to microfilm for a permanent record of all moves. Later, the PDP-11 will be interfaced with D&RGW's net IBM 370-145 for processing of other computer applications.

Other additions being considered are interface of hot box detectors along with various other detector systems and more video terminals.

PRODUCTIVITY

The Rio Grande has found a way to provide a unified, modern control center to control its territory efficiently and effectively. The dramatic improvement in productivity of the dispatching force provides a solid base of real-time train operation data which has never before been available. From a maintenance standpoint, present signal department manpower is better able to cope with a relay based system than one that is entirely solid state or computer based.

THE OUTLOOK FOR CTC: ARE THE RAILROADS COMPLETELY COVERED?

By Robert E. Heggestad

If a single answer has to be given to the question "are the railroads completely covered with CTC?" The answer would have to be no; however, any single statement made concerning many individuals in a group, is unfair to some of those individuals. In this case, to say that CTC throughout the industry as a whole is incomplete discredits those individual railroads that are virtually complete. Some railroads have 100 per cent of their mainline trackage covered by CTC. Some have their major through routes covered but still have main trackage left in ABS or manual block operation; and in some cases, many miles of major main track is still under ABS operation.

Another point indicating the fact that coverage is not complete industrywide, is simply to look at the amount of new construction in CTC taking place. Many railroads have significant new installations underway at the present time and many more miles in the planning stage.

Several factors are at work which will continue to affect the requirement for new CTC installations. These include increased rail traffic due to increases in certain types of business; increased rail traffic in a certain area due to re-routing for more efficient operation or take advantage of a better track structure, and changing economic factors both in terms of savings to be realized by a CTC installation and cost of constructing it.

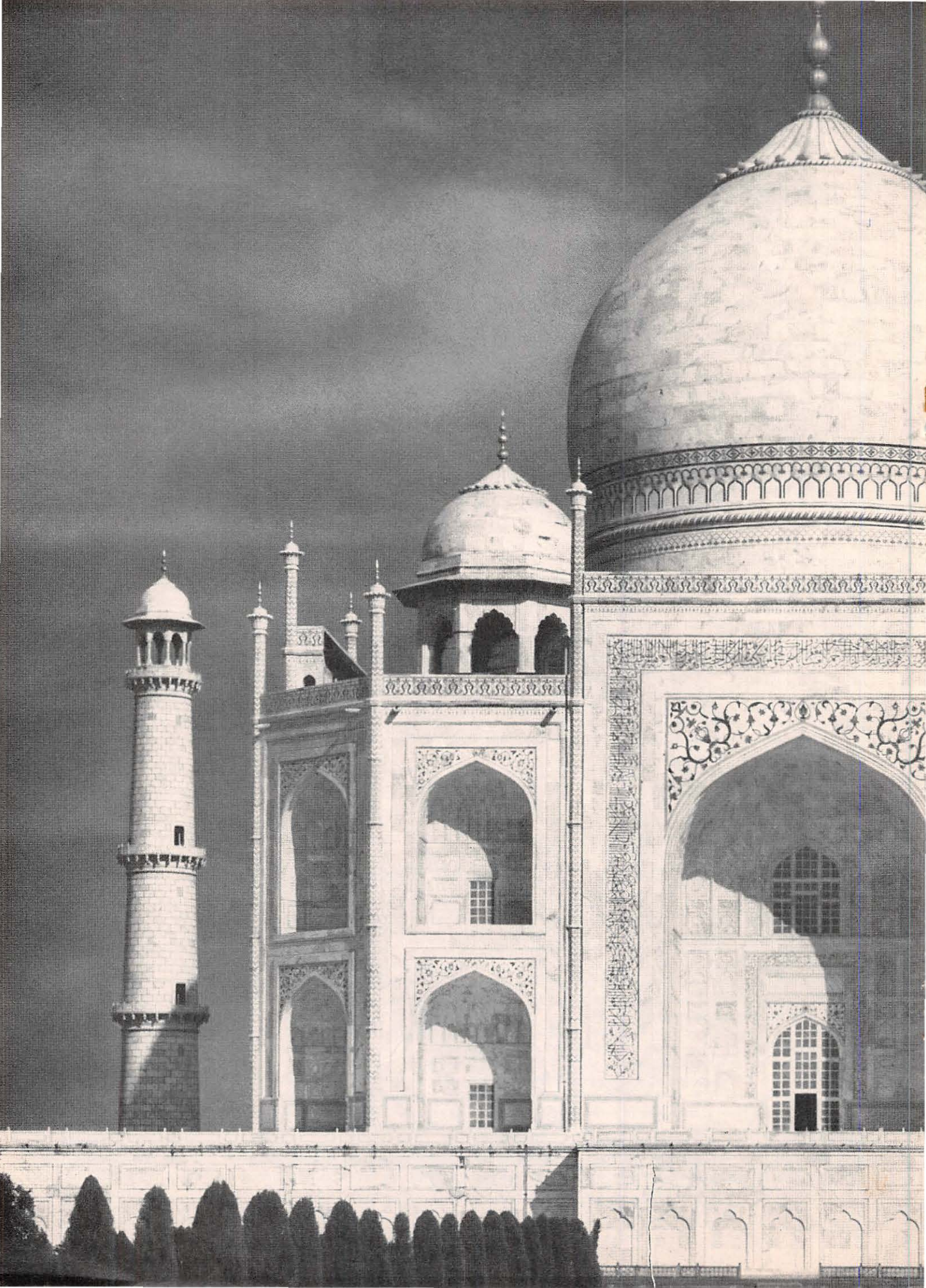
The progress of remote control of railroad signal facilities over the years has followed a pattern that appears to fall into three generations of technology.

1. Remote control of one or a few individual interlockings from an adjacent tower or yard office.
2. Installation of CTC on all interlockings over a full operating division with the train dispatcher controlling this from the division headquarters.
3. Consolidating all dispatching on a larger geographical basis such as a region on the large railroads or an entire railroad in the case of the intermediate size lines.

Most major railroads today are operating with a mixture of these three generations on different portions of their property. Only a few have arrived at the third generation on virtually all of their trackage.

The future of CTC lies in passing through these stages until all first and second generation control is retired and the third generation, as defined above, has absorbed essentially all of the operating property; however, even while this is happening new installations will continue to take place as changing traffic patterns and economic factors make it feasible or necessary to add CTC to a specific line. Many thousands of miles of additional CTC installation could be justified if the cost of such a system could be reduced significantly through a breakthrough in technology. This is an area that is ripe for exploration by the railroads and the supply industry which could bring the level of efficiency in control and operation of a railroad to a point highly competitive with other forms of transportation both in terms of economics and technology.

Going beyond this, there is a very real possibility of yet a fourth generation of control technology which would involve a much higher level of automation than is available on any mainline railroad today. This would be the ultimate control system in which all information required to effectively operate the railroad would be instantly available. Full advantage would be taken of all available tools so that the many factors involved in railroad operation can be optimized and the transportation of goods and utilization of railroad plant and equipment can proceed at a level of efficiency previously unattainable. Not until all but branchline operations have been upgraded to the third or hopefully fourth generation of control system can it be said that the railroads in America are fully covered with CTC.



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(Figures below are total given under specific categories in Business Analysis of Circulation NO. 18 SRDS, Jan. '74. edition).

CIRCULATION COMPARISON	Railway Age	Railway System Controls	MR	PR
CIRCULATION – Signaling & Communications Dept.	(237)	(1,874)	1,248	708
	2,111			
CIRCULATION – General Executives	(5,847)	(427)	6,464	1,858
	6,274			
TOTAL EFFECTIVE CIRCULATION	8,385		7,712	2,566
ADVERTISING COST PER 12 x SCHEDULE	$12,900*		$12,840	$5,700
COST PER THOUSAND PER PAGE	$128		$138	$181

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Note: In combining RAILWAY AGE and RAILWAY SYSTEM CONTROLS there is a factor of duplication. Where duplication exists, in top supervisor areas, your advertising receives double readership through two ads.

New training bulletins: in response to the demand

A great need for up-to-date and to-the-point training material has been expressed by railroads all over North America. In response to this demand, the Association of American Railroads has assigned the Education and Training Committee G the task of preparing a series of Signal Training Bulletins. The assignment was made about two years ago and the Committee's excellent progress is now supplying a steady flow of training bulletins.

Railway System Controls is featuring two AAR Signal Training Bulletins in this issue. These bulletins are only a sample of a total of 69 bulletins soon to be completed. RSC will present all of these valuable training bulletins as they become available. Reprints with binder and perhaps home study courses based on them may be available from RSC if the demand is indicated.

The unique application of signal equipment has been the stumbling block preventing the unlimited resources which so many other technical fields enjoy. On the job training is the only means which some signal departments have for training their signal maintainers. Cost, time considerations, and lack of training material have prevented many C & S departments from establishing an effective training program. High cost is attributed to the man hours needed for preparation of training material and implementation of an effective training program.

Yesterday's training material cannot fill today's needs. The new Training Bulletins will take the place of outdated and inconsistent training material previously available. Each bulletin is limited to the subject being presented and the format is consistent throughout the entire series. RSC will be a means of distributing this major contribution to signal training material. Although the bulletins are oriented towards signal equipment, much of the information is applicable to communications as well. If your signal department needs additional copies for supplementing your signal training program, or as a prime reference source please contact RSC for complete information.

Committee G

After the Association of American Railroads recognized the need for new training material and continuous revision of old reference material and documents, Committee G was formed. Throughout the years, Committee G has included in its membership representatives from almost every major railroad in North America. At any given time, twelve or more railroads are represented. These repesentatives are usually in a supervisory or training position with their respective C & S departments. The committee meets at least three times a year for a review of completed assignments and distribution of new assignments. Between meetings, committee members work on their assignments in addition to normal responsibilities in their C & S departments.

Preparation of Signal Training Bulletins has been the committee's major concern for the last two years. The conceptual guide to which the committee must adhere is as follows:

Objective To provide the North American Railroad industry with a source of educational information to assist in training new Signal Department employees and upgrade present personnel.

Method Members of Committee G will prepare individual Signal Training Bulletins for each device and basic circuit used in signaling. The bulletins will be as short as possible but must conform with the requirements of the approved format.

Application The members of Committee G consider the Signal Training Bulletins will be valuable in a variety of applications. Some possible uses are as follows:

(a) Roads contemplating the introduction of training programs may reduce the expense and labor of preparing training literature. By utilizing the Signal Training Bulletins for the basics, the railroads requirement would be reduced to the preparation of Signal systems material.

(b) As handout to new employees, it could be utilized in various ways:

(i) Handout with instructions to read: Not recommended without some follow-up.

(ii) Handout with instruction to read and prepare for periodic examinations (home study training).

(iii) Handout with instruction to read and prepare for an entrance examination during the man's probation period. The results of the exam could be used to determine if a man is to be retained and/or is qualified to enter a formal training program on roads where such programs exist.

(iv) Pre-course reading for employees scheduled to attend classroom training.

(c) As supplements to Railroad standard practice bulletins or rules for construction, maintenance and inspections. The "what to do" approach of standard practices and rules may be made more comprehensible with the "how it works" supplement.

(d) As a source of concise information to orient new engineers and technicians to the basic purpose and operation of signal equipment.

(e) As reference material for older employees.

Note: The Signal Training Bulletins are being prepared with the assumption that those receiving the bulletins have some knowledge of basic electricity and magnetism.

1. Title: DIRECT CURRENT NEUTRAL RELAY—GENERAL

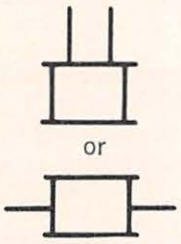
2. Definition

Relay: A device that is operative by a variation in conditions of one electric circuit, to affect the operation of other devices in the same or another electric circuit.

Relay, DC: A relay designed to respond to direct current.

Relay, Neutral: A relay which operates in response to a predetermined change of the current in the controlling circuit, irrespective of the direction of the current.

3. Symbol:



or

Single winding relay

4. Description:

The relays described in this bulletin are referred to as vital relays. Because these relays are manufactured from precision components and meet high standards with regard to operating characteristics and dependability, they are suitable for use in circuits which directly control block signals, crossing protections, etc. Since lives and property of the public and railroad personnel are dependent on the safe and proper operation of this equipment, it is vital the relays be reliable.

Fig. 1 (a)

Fig. 1 illustrates two types of dc relays in common use in signal installations. Fig. 1 (a) is a shelf or wall mounted, relay where electrical connections are made directly to binding posts on the relay. Fig. 1 (b) is a plug-in relay. The wiring for this type is connected to a mounting base which permits easy, safe replacement of a relay without disturbing connections. Plug-in relays take up less space in the instrument housing.

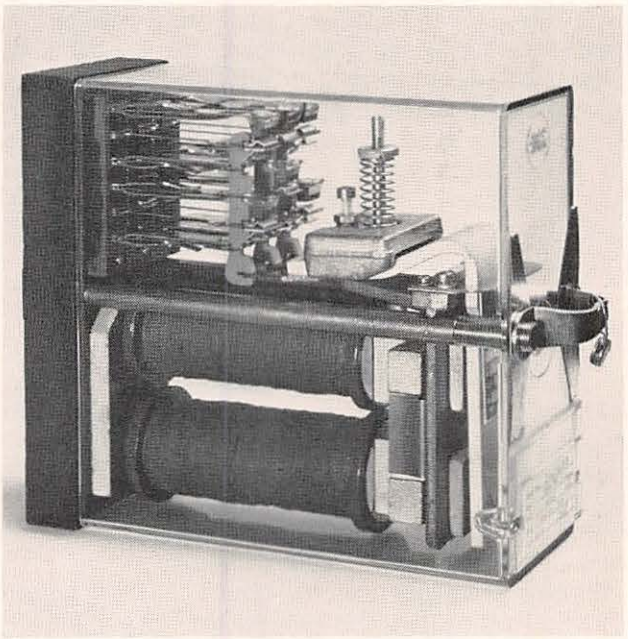


Fig. 1 (b)

The shelf or wall mounted relay will be used for illustrative purposes in these bulletins. Additional information on plug-in relays will be found in Signal Training Bulletin C-5.

The various designs, purposes and operating characteristics available in dc relays are often indicated by descriptive names. They are commercially classified as neutral, biased, polarized, flasher and others. Under several of these classifications there are a number of special purpose designs. For example, both neutral or polarized relays can be made slow pick-up, slow drop-away, etc.

The neutral relay was selected for the introductory bulletins since almost all dc relays are basically of this type with modifications to permit special applications.

In this general introduction to dc relays the indentification of the physical components is emphasized.

Fig. 2 is a cut-away of one manufacturer's typical dc relay. The principal parts are identified in the illustration and will be frequently referred to in further studies

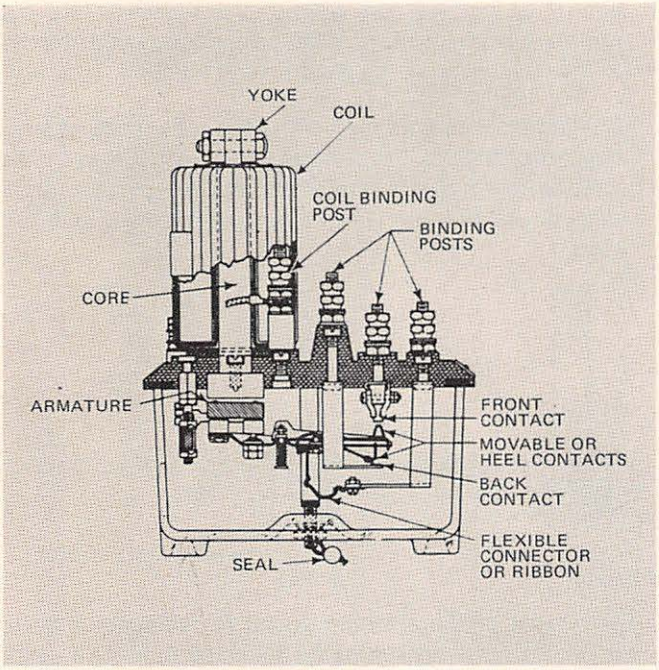


Fig. 2

or relays. Relays of other manufacturers will contain similar parts which may be arranged differently.

Note that all moving parts are enclosed in a sealed transparent compartment (glass or plastic).

Name plates, as illustrated in Fig. 3, are mounted on the front of all dc relays and convey important information. See Fig. 1 (a) for an illustration of where the name plate is mounted.

(a)

Fig. 3

(b)

Note that on the plate, the style or type is identified, the position of the binding posts connected to the contacts are shown, the coil resistance is indicated along with other information such as manufacturer, ordering number, serial number, etc.

The binding post diagram illustrates the actual position of the posts on the top plate and is extremely useful. The name plate illustrated in Fig. 3 (b) shows that this relay has four front, back and heel terminals. The circuit wiring plan will indicate the proper binding post by terminal number and contact symbol.

A label inside each relay compartment gives the exact operating characteristics of the relay. An example of a typical label is shown in Fig. 4. An explanation of the operating characteristics is covered in Signal Training Bulletin C-4 Direct Current Relay Operating Characteristics.

DROP-AWAY		PICK-UP		WORKING		SER: L 20989
VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	OHMS 2
	.054			.206	.103	INSP. DATE Ab 5-12-73
~~SLOW REL.~~		~~SLOW P.U.~~				ORDINARY ACT.

Fig. 4

5. Purpose and Application:

This is the initial bulletin in the dc relay series and is intended to introduce the relay in general terms. Therefore, to explain the purpose of a relay it will be compared to an electric light switch. When the light switch is on, contacts in the switch provide a path for electrical energy from the ac source to flow through the lamp filament and energize it. Similarly contacts in a relay are inserted between a source of energy and a signal device. The main difference and advantage of the relay over the switch is that it may be controlled, automatically, eliminating the need for manual operation and removing the hazard of human error. Safety, of course, is of utmost importance in signaling.

The applications of dc relays in signaling are numerous and as further studies are made it will be recognized that there is no piece of apparatus more essential to signal operation.

6. General Information:

Many railroads have instructions outlining installation, maintenance and inspection procedures with regard to relays. It is most important that maintenance personnel become familiar with their company's instructions.

7. General Rules for Relays Maintenance:

At Regular Intervals:

A. Check binding post nuts and tighten if necessary.
B. Dust relay and determine that it is free of foreign material.
C. Check seals to see that they are intact.
D. Inspect to see that contacts are not pitted or burnt, all parts are in place, and the interior and exterior of the relay is moisture free.
E. Check the relay and its mounting for stability.

8. Detailed Operation:

There are training bulletins for each commonly used type of dc relay and they include details of their operation.

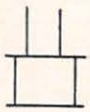
1. Title: MAGNETIC STRUCTURE DIRECT CURRENT NEUTRAL RELAY

2. Definition:

Relay DC: A relay designed to respond to direct current.

Relay Neutral: A relay which operates in response to a predetermined change of the current in the controlling circuit, irrespective of the direction of current.

3. Symbol:



4. Description:

The magnetic structure of a dc neutral relay consists of the backstrap, core, pole pieces and armature. The magnetic structure of a neutral relay is illustrated in Fig. 1.

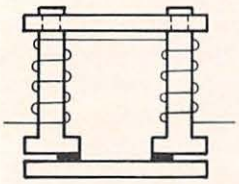


Fig. 1(a)

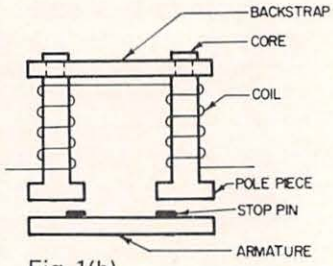


Fig. 1(b)

5. Purpose and Application:

The purpose of the magnetic structure is to detect the presence or absence of direct current in the controlling circuit (coil circuit). When direct current (dc) is flowing in the coils the armature will be magnetically attracted to the pole pieces as shown in Fig. 1(a). Fig. 1(b) illustrates the de-energized condition when insufficient or no current is flowing. The movement of the armature is reflected into other circuits by contacts that are connected to the armature and move with the armature to open or close other circuits.

6. General Information:

Maintenance of relay coils, armatures, etc. is normally a shop function but field forces should periodically inspect the coils for insulation deterioration and the armature linkage to ensure it is intact. The backstrap nuts or studs must be kept tight.

7. Detailed Operation:

When direct current is passed through the coils, magnetic lines of force are produced. These lines of force will flow through the iron or steel cores of the relay and cause a magnetic attraction between the lower portion of the cores (pole pieces) and the armature. The armature is hinged and will pivot upward toward the pole pieces as shown in Fig. 2(a). When electrical energy is removed the magnetic flux decays and the armature is released from the pole pieces and is forced to the down position by gravity. (See Fig. 2(b).

The armature is equipped with stop pins made of non-magnetic material to provide an air gap between the armature and pole pieces. This ensures positive drop-away of the armature when energy is removed from the coils.

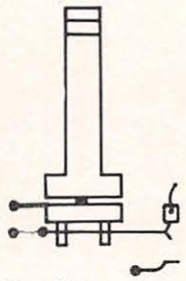


Fig. 2(a)

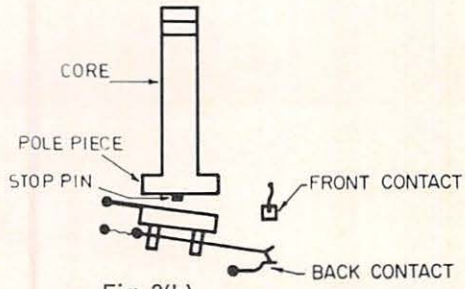


Fig. 2(b)

Movement of the armature alone is obviously of little value. Its movement must be reflected into the control of other circuits. This is accomplished by fastening heel contacts to the armature, each being insulated from the other and the armature. See Fig. 3. When the relay is de-energized a physical connection exists between the heel contact to its back contact to provide an electrical path.

Conversely, when the relay is energized the electrical path is provided from the heel contact to its front contact. The operation and application of relay contacts is covered in detail in Signal Training Bulletin C-3.

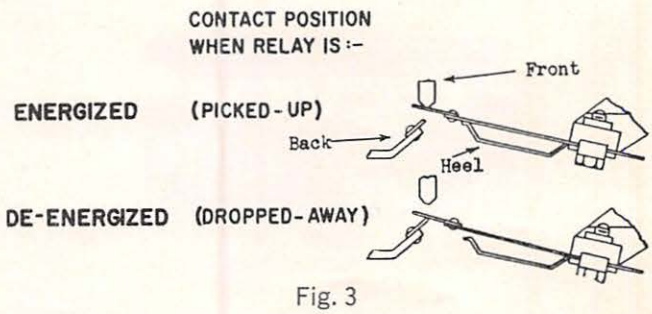


Fig. 3

The amount of magnetic flux produced is dependent upon the magnitude of the current, the number of turns of wire in the coil, the composition and size of the core and dimensions of the airgap. In a relay, the magnetic flux produced must be strong enough to overcome the airgap between the armature and the pole pieces and the force of gravity. Therefore, the applied voltage must be large enough so that enough current flows through the resistance of the coil windings to pick up the relay.

Coils for a dc relay are designated by their resistance whose values range from less than 1 to 1000 or more ohms.

Refinements in surge protection

Surges from lightning and power sources have long been a problem for people working with electronic equipment on the railroads. Many approaches to the problem have been taken and all of the solutions found have been quite adequate for protecting the traditional equipment of the past. Today, new surge protection is being developed to protect the solid state components in much of the equipment being used in signaling and communications. R. L. Pike, assistant general manager-chief engineer, Safetran Systems Corp., describes the action they have taken to supply adequate surge protection.

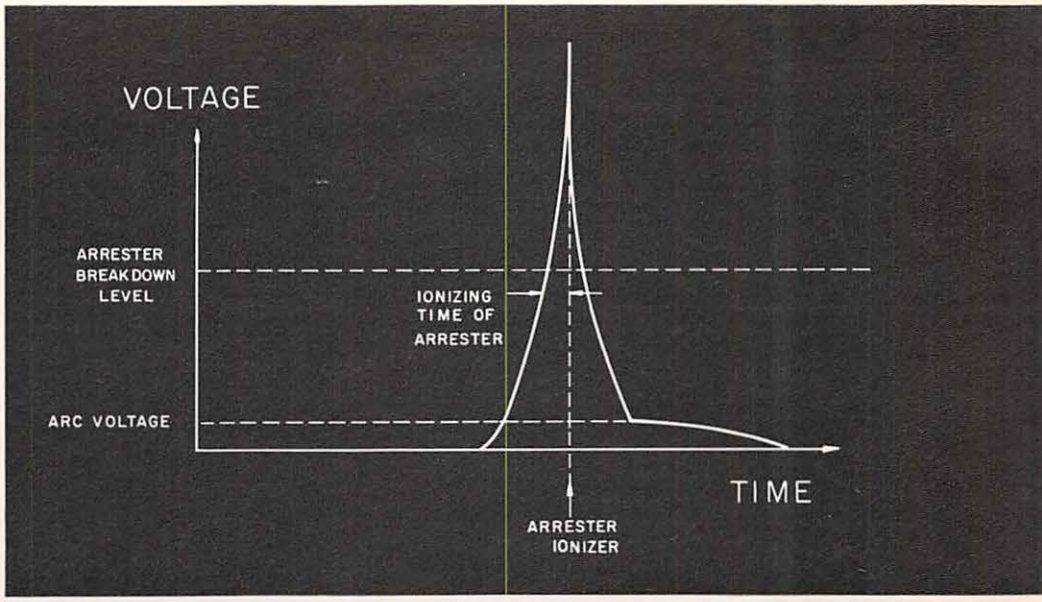


Figure 1 shows drawback of a high DC firing point.

Primary Arresters

The type of equipment to be protected in the not so distant past was totally relays and motors. To protect these relays and other electrical equipment from damaging surges the Gap Arrester was developed in 1940 and other arresters followed.

The basic premise of a gap arrester is to provide a fixed air gap which is to break down and shunt the surge to ground or equalize a metallic surge voltage line to line. Since relays, motors and other railroad electrical equipment must meet 3000 volt insulation breakdown ratings, a gap breakdown of 1000 volts or below is used.

To achieve this lower level consistently a dual gap is required. The first gap is .005 inches to .008 inches and is from metal to a special high resistance block. The second, high power gap, is .024 inches to .040 inches. The first small gap acts as a trigger to provide ionization of the larger gap. Alone the larger gap would breakdown at from 1800 volts to 3000.

The first small gap cannot maintain an arc due to the high resistance of the special block. The arc, if any, must be between the metal plates which, on account of their design and spacing, quickly extinguish the arc, or burn back to a point where the arc is extinguished due to the gap being widened, depending on the power behind the surge.

Another feature to consider in this arrester is the construction. When very large currents are flowing, a very strong force field is set up that can move things around if they are loose or weak. That is why a very heavy bolted construction is used to resist these forces that would change the next firing point or destroy the unit entirely.

For vital circuits, the dual gap, burnback arrester is the only suitable type as it has a large safety factor against shorting. To maintain this capability the unit is mounted either vertically or horizontally with the teeth pointing up so gravity will drop molten metal away from the gap.

The dual gap toothed arrester can handle high power surges again and again through tooth burnback. However in non-vital signal circuits higher power surges are seen. An example is between the ground bus and the track at locations where AC service is taken and thus the arrester must pass the surge to the rails. Power lines are usually long, which allows more energy to be picked up.

To allow higher power surges to be handled, the burnback feature must be replaced with a heavy metal piece. The gap during heavy arcing won't change much and the arc will be sustained over a larger area. This also means more metal is melted and splashed around which could cause a short to occur. This arrester still uses the double gap method for low firing voltages, less than 1000 volts.

A further step towards vital protection is the use of an arrester without a full open circuit gap. Here a deliberate bleeder resistance of about 1000 ohms is made across the arrester by not insulating the resistance block with a gap. This lowers the triggering point down to 150 to 200 volts and is used as shunt protection designed for use across all track lead, across low voltage lamps for filament protection, and similar non-vital circuits where low voltage protection is desired. This unit also holds down static charge buildup via the bleeding action of the 1000 ohms.

For AC Power Lines we can stack the bleeder resistance type arrester so that the gap voltage during arcing will not be low enough to be sustained by the normal AC voltage present. This is extremely important as it allows full protection of the equipment at all times. Other types of power line protectors have rising type of breakdown voltages as the power of the surge increases. This rising voltage can often go higher than the protected equipment can withstand.

Our Power Line Protector does not need current limiting devices as the arc drop of the five gaps is the major portion of the peak value of the supply voltage. For supply transformers capacities up to 1KVA, the difference between the arc drop and the peak voltage is readily absorbed in the transformer without prohibitive follow-through current. For capacities greater than 1KVA, put two Power Line Protectors in series. Other combinations of Protectors are used for higher KVA ratings.

The series of primary arresters has served well for protection of relays, relay contacts, motors, switches and other signal equipment. They do have some drawbacks that this early protected equipment was able to handle. One, these arresters are slow. As a fast surge voltage rises to and above the breakdown voltage of the arresters, it will ionize the air in the gap. However, before it does ionize completely enough to form an arc, we can have a pulse voltage of several microseconds dura-

Development of Solid State equipment brought about a whole new set of problems in the field of Surge Protection

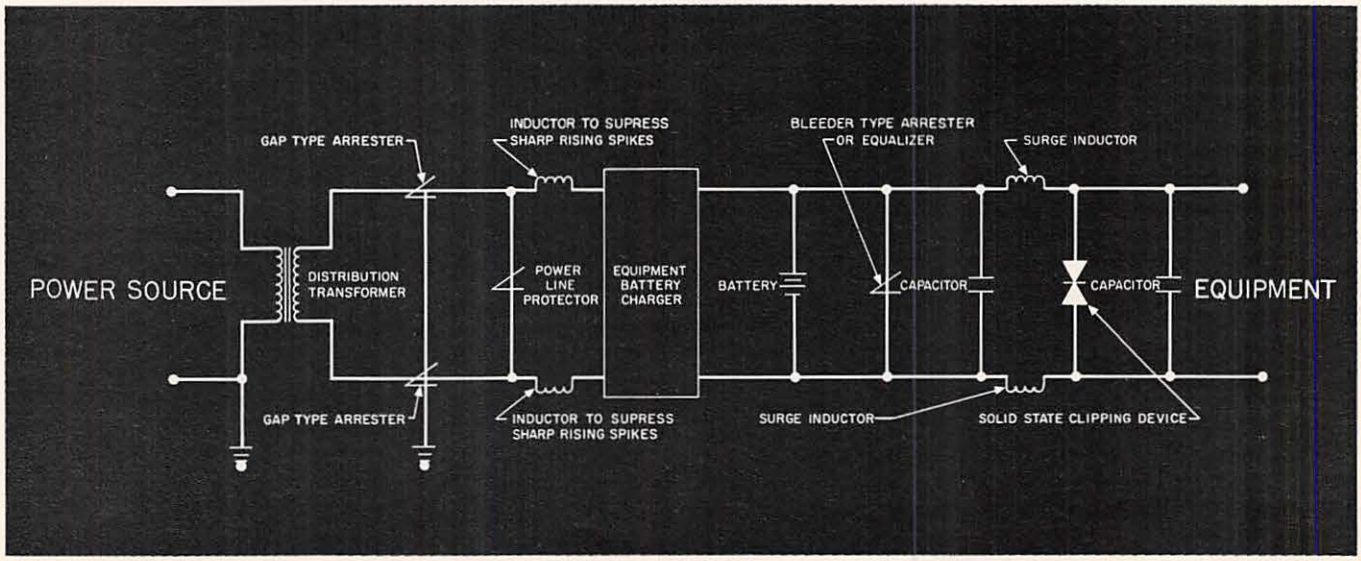


Figure 2 shows full protection for the power input side of equipment.

tion much higher than the DC firing point of the arrester. (See Figure 1.) The other drawback is the DC firing point is high in relation to newer circuits to be protected.

Solid State Arresters

The development of Solid State equipment, transistors, and silicon rectifiers brought about a whole new set of problems in many areas including Surge Protection.

Semiconductors cannot withstand very high voltage. Normally we are talking about 30 to 300 volts for general transistors and rectifiers and 100 to 800 volts for power handling devices. In addition, semiconductors are polarity sensitive. So if a reverse polarity shows up it takes but a very few volts to cause failure. Also, time is very important as the mass of a semiconductor is very small. It takes only micro seconds to destroy a semiconductor junction, where relays have large inductances and mass to absorb energy until the surge is snubbed.

Semiconductors in the signal area are also very limited in current handling capacity. So if surges 'get in' that cause devices to turn on at the wrong times an internal current surge can take place and destroy operation or the current in the surge itself can do the damage.

Primary arresters cannot protect Solid State equipment by themselves. They are too slow and fire at too high a voltage but they can handle the power found in surges and that is a saving grace. As the problem was examined and solutions investigated it was found that the devices needed to protect Solid State equipment could not also serve as primary arresters. The surge power was too great and the devices that could handle it were too costly.

Full Protection

Let's start with AC power lines to our equipment. We have noted that there is a primary Power Line Protector which is used across the line for metalic surges and gap arresters from each line to ground. There are fast overshoot voltages that will be missed by the arresters; and to eliminate these we add inductance after the arrester, just before the equipment, to absorb this transient and release it at a safe level.

After the power lines we have the equipment referred to, usually a battery charger and batteries. The surge spikes that might have passed through the battery charger have been stopped. However, the charger itself can sometimes create surge spikes and the lines to and from the batteries can pick up surges. The battery is a huge capacitor but is not usually located so as to be an effective capacitor for absorbing fast surges. To snub surges on battery lines the following steps are taken, *all as close as possible to the equipment being protected.*

First, to take out the fast high frequency surges, a capacitor is put in. In addition to this shunt capacitance it is necessary to clip or clamp the surge to maximum value. This is either done with a Zener diode pair or a back to back Selenium pair. Selenium is our choice as it has a self healing characteristic which allows it to take overloads a Zener never could. But a Selenium is a semiconductor and does have low maximum current capabilities. To keep within these ratings, the high fast current in the surge must be made a low, slow current. It is practical to use an inductor for this and one is put in each line. The picture looks like that shown in Figure 2.

Critical Point

Up to this point we have not mentioned a point critical to proper operation of these circuits. You will note that a primary bleeder type arrester is in the battery circuit. You may ask how the 150 volt trigger level of the bleeder can ever be reached if the selenium is clamping at 30 volts. Well, the surge voltage on the input side of the inductor rises to full value instantaneously and then current begins to flow and voltage is transferred to the other side. This is the limiting of surge power to safe levels for solid state protectors. If the surge is big enough, it raises the voltage on the input side of the inductor to the firing point of the primary arrester for a long enough period of time for the primary arrester to fire. So the primary arrester is our high power safety valve which protects our lower power handling, faster Solid State Protectors. That is how we use the primary

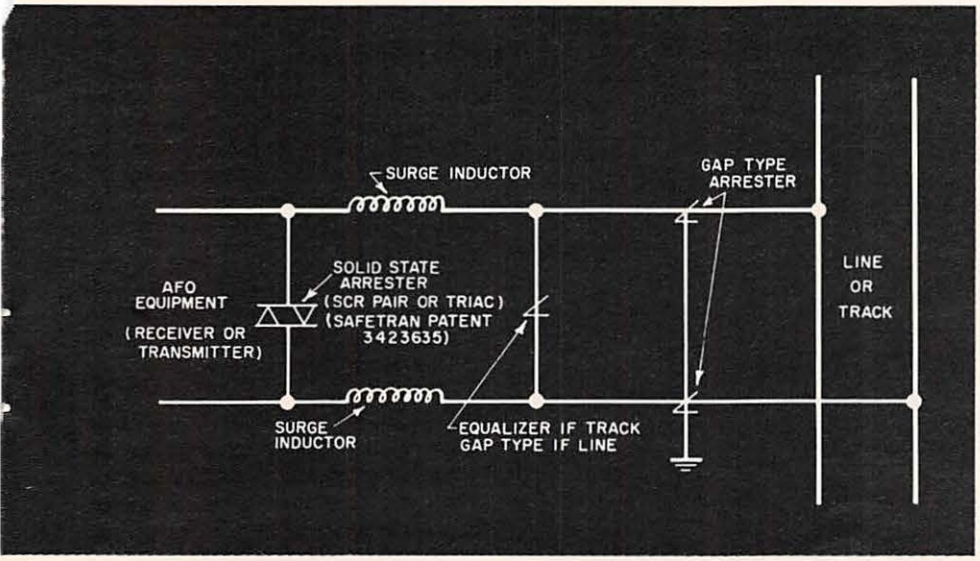


Figure 3 shows protection for output side of equipment.

arresters as part of the total protection package.

The input of the equipment has been protected and now the harder part comes, the outputs. The outputs feed track circuits, code lines and other line circuits, all subject to high power lightning surges. Also we must be very careful not to affect the information which is carried by means of AC, DC or forms thereof as well.

Since the DC portion of the line is usually operating relays, our primary arrester can protect them. The other equipment—AFO, Transmitters and Receivers—deals with AC and is Solid State where additional protection is required.

Because of the higher power surges, we must use a device capable of handling the higher power let through by the inductors before the primary arrester fires. The selenium can only go to 30 amps. The device that can do this job is a Silicon controlled rectifier or Triac. They can go well over 300 amps for reasonably priced devices. These devices have trigger controlled gates and the trigger voltage can be selected from 20 volts to 400 volts by proper component selection. The triggers operate in the nano second time scale and the SCR or Triac goes to full conduction in about a microsecond. So it gives the good, fast protection that is needed.

The SCR or Triac has a characteristic which has to be designed around. Once they are triggered they drop to an ON voltage of about 0.5 volt and it takes very little current to hold them there. That is why we don't use them on battery circuits. But on the AC circuits we can use capacitors to block the DC so they work out fine on our information circuits. (See figure 3).

We do have "Boosters" that will raise the ON voltage in 2.5 volt steps so that on DC track circuits the DC doesn't have to be blocked. The fewer the components, the less there is to go wrong.

Another advantage of this type of Solid State Protection is that if the surge is too big and primary arresters can't hold it, the SCR or Triac will short circuit, giving its life so to speak, to protect expensive equipment to the end.

Grounding

All the proper application of these protection means can go for nothing if the path to ground is no good. Thousands of volts can be developed by moderate resistances. Also, due to the high frequency, sharp turns in ground runs can cause lightning surges to see the run as a high resistance.

So number one is to keep the ground path resistance to the earth grounding stake low. Use at least #6 wire, as the surge current is going to be in the 1000 amp range some of the time. If you are going to ground a number of circuits in series and take off the end of the circuit path, a much heavier equivalent gage conductor must be used to prevent high voltages developing from one end of the bus to the other that could damage equipment. It would be better if each circuit were run to a main ground stud separately.

Drop ground wires straight to the floor off the terminals. Don't make a sharp bend back through the backboard as it will add resistance to your ground. It would be best if the earth grounding rod came right up through the floor so bends would not have to be made to get to it. The metal house or case should have a good electrical connection to the ground rod. In large factories we've had large copper rods put right down through the floor deep into the earth to obtain a ground for special screen rooms.

For the ground itself here are some values that may be of help to you.

1. Underground water or gas piping—less than 3 ohms.
2. Metal building frames with foundations and metal well casings—less than 25 ohms.
3. Rod about 5 feet into ground in: Clay, heavy soils—2 to 100 ohms 25 avg. Sand and gravel—35 to 2500 ohms 500 avg. Ashes and cinders—4 to 40 ohms 15 avg.
4. Rods in buried concrete such as footings, etc., especially good in rocky areas. Near Average or below for soil type buried in.
5. Rods should be about 10 feet deep.
6. Diameter of rod doesn't make much difference as strength for driving determines a larger size than needed.
7. Spacings of rods should be ten feet or more and large houses, 8 by 8 and up, should have four or more equally spaced rods around house and electrically tied to the house.
8. If bedrock doesn't allow a ten foot driving depth, buried grids or cables should be considered. Buried one foot or more.
9. A few deep rods are better than more shallow rods.
10. The use of a grid system in sand or such calls for the opposite, many short pieces in interconnecting squares.

The present solutions that have been developed are by no means the final word on surge protection. As systems change and equipment changes the ways and means of protecting it from surges may require entirely new surge equipment.

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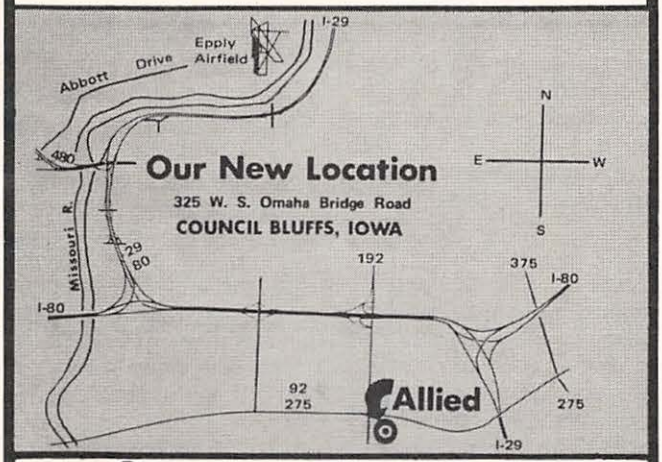

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Circle 7 on Reader Service Card.

People

AMTRAK.—**Joseph J. Schmidt** appointed director of planning and development, with responsibility for planning all new equipment programs and associated maintenance facilities.

BOSTON & MAINE.—**A. J. Connell** appointed special assistant to the president with responsibility as chief liaison officer to the EDP Steering Committee and EDP Study. The Systems and Research Division has been transferred to the office of the comptroller.

LEHIGH VALLEY.—**L. J. Trinchere,** director data processing, Bethlehem, Pa., appointed assistant to vice president for system development.

NORFOLK & WESTERN.—**William Brenton,** administrative assistant to the assistant vice president-Staff, Roanoke, Va., named manager of merchandise data, with responsibility for design and development of computerized merchandise traffic systems.

PENN CENTRAL.—**Benjamin J. Gordon** has become chief engineering officer with principal responsibility for maintenance of way, construction and signal systems, succeeding **Charles T. Popma,** named an engineering assistant to the senior vice president-operations.

Suppliers

GTE LENKURT INC.—**Mrs. Penny Prior** has been appointed assistant sales engineer, government & industrial sales, Western District, San Carlos, Cal.

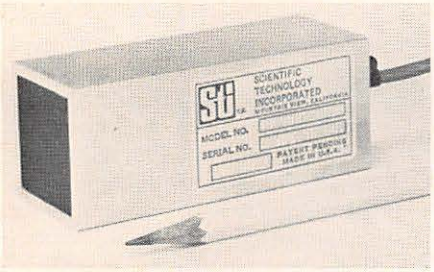
INTERNATIONAL COMMUNICATIONS CORP.—**Paul E. Payne,** manager product development, Miami, Fla., promoted to vice president-engineering.

LYNCH COMMUNICATIONS SYSTEMS, INC.—**Sherman B. Weiner** has been named vice president, engineering, Reno, Nev.

NATIONAL ELECTROLAB LTD.—Has been appointed exclusive Canadian distributor for the **Harmon Electronics** line of selective levelmeters. The Vancouver, B.C., company will provide sales and complete service facilities for all of Canada.

PULLMAN INC.—Has worked out a tentative agreement in principle for the acquisition of **Computer Identics Corp.,** Boston, and, through that transaction, **ACI Systems Corp.,** a wholly-owned subsidiary of Computer Identics.

RSC Product News



Non-contact sensor

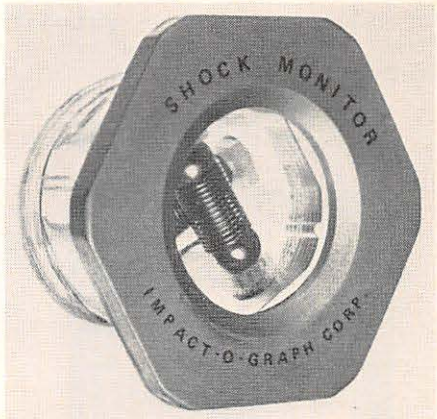
Model 3093 OMNIPROX sensor is said to provide a self-contained system component for detecting, monitoring and controlling almost any material that the eye can see, whether solid, liquid or gas. The wide sensitivity adjustment of the sensor permits, for instance, seeing a transparent surface or seeing through it at the user's option. It is also said to signal color and texture changes and read codes.

Standard range of the sensor, when used as a proximity sensor, is 24 in. for a 90% reflectance surface and 15 in. for an 18% reflectance surface. With a retrotarget the beam make or break range is 20 feet. Longer range units are available. A visible LED alignment and operation indicator is provided.

Operation of the sensor is said to be unaffected by ambient light, even bright sun. It ignores environmental contaminants such as dust or fog because a form of AGC maintains preset sensitivity. All circuitry is solid state and the unit is completely self-contained and sealed in a 1½ in. square by 3.9 in. long aluminum housing. *Scientific Technology Inc. Circle 101 on Reader Service Card.*

Service monitor

The Gertsch FM-10CS is now capable of testing new receivers equipped with crystal filters to achieve increased narrowband capability. The service monitor has internal, electronic sweep, with sweep rates variable from 10 to 100 Hz. In addition to being a service monitor, it can sweep IF's and crystal filters up to 1MHz bandwidth. Display of the output waveform is available on an FM or AM oscilloscope plug-in. These features are said to make the FM-10CS a highly-stable (synthesized) narrowband sweeper. *Singer Instrumentation. Circle 102 on Reader Service Card.*



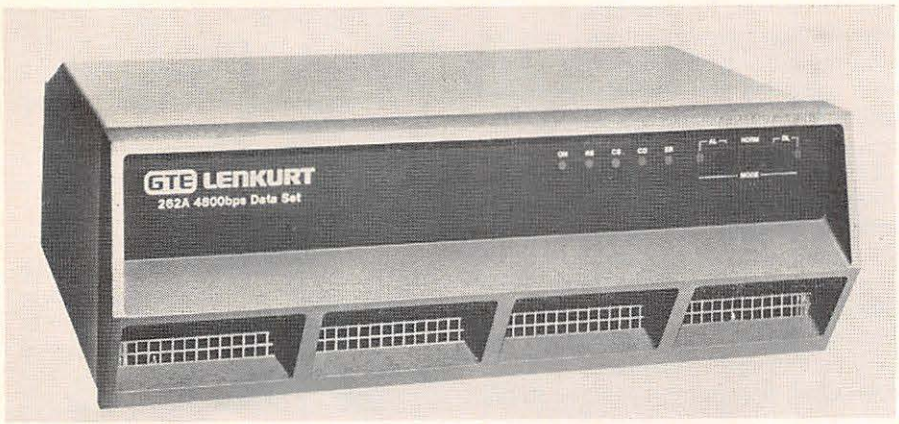
Shock monitor

An all-directional shock indicator in a threaded Mil-Spec type metal plug (intended for impact and shock monitoring of equipment during handling and shipment) mounts in rigid containers or directly to equipment.

Any direction of shock or impact above the factory preset value will permanently trip the unit and give a clear indication of excessive shock exposure. The aluminum anodized unit with clear observation window threads into a 1 7/16-18 NEF hole or with locknut in a 1.45 in. hole in material to ¼ in. thick.

The shock monitor is available with factory preset "g" ratings of 5 to 100 g's. As an option a self-contained humidity indicator may be included in the monitor plug.

By checking the monitor plug through the view window, the impact exposure can be determined. Any shock from any direction above the specified "g" ratings will give a positive indication. Responsibility for shipping and handling damage can be established at every transfer point. *Impact-O-Graph Corp. Circle 104 on Reader Service Card.*



Data set

The 262A Data Set transmits and receives serial binary data at a rate of 4800 bits per second and is capable of half or full duplex operation over conventional transmission facilities.

The 262A operates over unconditioned type 3002 channels to process data from terminal equipment such as business machines, computers and instrumentation systems. It is particularly suited for point-to-point and multipoint polling system applications.

The 262A complies with EIA Standard RS-232-C and CCITT Recommendation V.24. It operates end-to-end, and is plug interchangeable with the Western Electric type 208A Data Set.

Features include automatic adaptive equalization with an initial receiver training time of less than 50 milliseconds, status indicator lights, and switchable built-in loop test facilities. Full-duplex switched network to private line operation or alternate voice operation can be provided. *GTE Lenkurt, Inc. Circle 103 on Reader Service Card.*

Outlet tester

The model OT-5 hand-held, battery operated outlet tester is used to determine a variety of possible faults or hazardous conditions on electrical wiring. For use with either existing or new in-

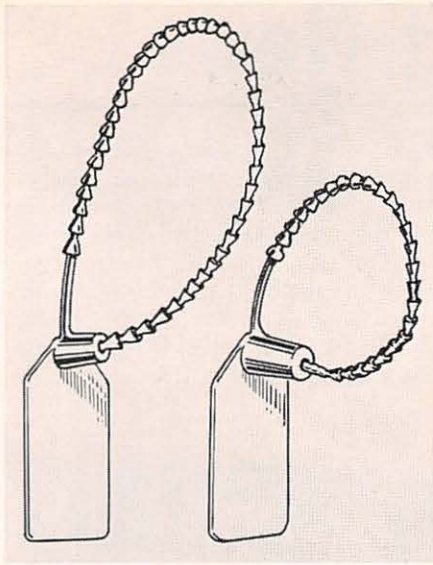
stallations, it is said to insure that wiring complies with applicable codes.

The compact Model OT-5 consists of a volt-meter, ground tester, a rotary selector switch, indicator lights, and adaptor cables. Any 2-, 3-, or 4-wire outlets, single or three-phase, with voltages ranging from 0 to 500 volts, and 50 to 400 Hz can be tested with this instrument. The volt meter measures line-to-line and line-to-ground voltages. The ground-tester checks outlet ground resistances from 0 to 50 ohms. By using the rotary selector switch, the tester will detect electrical hazards and faulty wiring, including open phase, grounded phase, unwired terminal, or reversed polarity.

The unit operates on a 5.6 volt mercury battery. The voltmeter accuracy is within 5% of full scale at 50 to 60 Hz, with an input resistance of 5,000 ohms. The 8-pin octal plug mates with the socket of the ready-to-wire adaptor cable. The instrument measures only 5⅞ x 3⅛ x 2¼ in. and weighs 1⅛ lbs. *Bio-Design, Inc. Circle 105 on Reader Service Card.*

Pull-tite seal

The plastic Pull-Tite Seal is now available in lengths of nine inches or less. A fourth locking catch inside the threading receptacle has been added for better security. The Pull-Tite seal offers a positive locking device suited for metal and fibre drums, valves, fire extinguishers, vending boxes, and other equipment requiring tamper-proof protection. The design incorporates a self-locking mechanism that cannot be released without breaking the seal. Available in a variety of colors for color coding, a tab also permits consecutive numbering and/or message imprint. *E. J. Brooks Company. Circle 106 on Reader Service Card.*



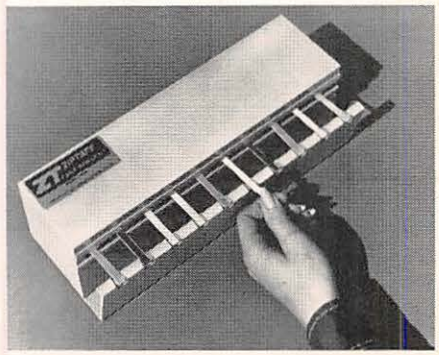
Time code generator

The Chrono-log Series 9000 Time Code Generator/Readers is a low cost instrument for generating and reading serial modulated time codes. It allows recording time on analog tapes and reading back the time code during playback.

The codes offered are IRIG A, B, or E (100Hz or 1KHz carrier) and can include a day of year calendar. A multi-code option with all four codes includes automatic selection of the input code being read. In the generating mode, the time base can either be externally supplied, or various internal oscillators can be selected, depending upon the stability desired. Parallel buffered BCD outputs are offered, with milliseconds if desired, in positive or negative logic, TTL compatible, for readout to a data system during both reading and generating modes. The unit is 1¾ in. high for a 19 in. rack mount. *Chrono-Log Corp. Circle 107 on Reader Service Card.*

High-speed printer

Arrival-departure schedules of trains, commercial airlines, long-distance buses and trucks can be handled fast by Vogue Instrument Corp.'s low cost, high-speed printer. Called Vogue 400C, the printer can be coupled to ordinary telephone lines to receive information directly from a remotely located central computer. Scheduling information, equipment rosters and passenger manifests are printed out at up to 600 lines per minute. The 400C can print a full page in 6 seconds. It produces from one to six clean copies without penetration controls or adjustment. The ribbon-reversing system makes it possible to print more than 300,000 lines using a single standard commercially available ribbon. The 400C is completely compatible with all major minicomputers. It ranges in price from $9,800 to $13,800, depending on system configuration. *Vogue Instrument Corp. Circle 108 on Reader Service Card.*



Color coded ziptape

Cable coding tape, previously available only with alphabetical and numerical symbols on a white background, is now available in the complete NEMA code of colors. The tape is plasticised and pressure sensitive with high tac adhesive for instant use.

ZipTape comes in 1000 inch lengths packaged in a dispensing cartridge for use in the Model ZTLB Bench Dispenser. The Bench Dispenser has a capacity of ten individual cartridges, with all colors readily visible for quick selection and application. The tape sticks to all clean surfaces and can be removed leaving no residue. *Zippertubing Co. Circle 109 on Reader Service Card.*

Ear-to-ear communication

An ear-to-ear communication device called Ear-Com is available from Lear Siegler, Inc./Electronic Instrumentation Division. Heart of the Ear-Com system is a small transducer that fits in one ear and utilizes sound energies formed by speech. The wearer speaks as well as hears through his ear. Speech sound waves are transformed into a perfect reproduction of the human voice

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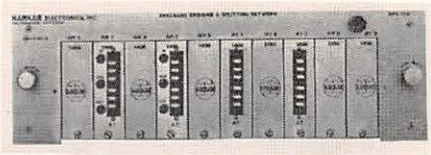
and then transmitted to a radio command post or to persons in the area who are wearing an Ear-Com. Surrounding noise is completely eliminated, permitting interference-free communication. Ear-Com can remain in a receiving mode when not being used for transmission, allowing wearers to continuously receive messages without stopping work. *Lear Siegler, Inc. Circle 110 on Reader Service card.*

Modulation mode identifier

An electronic device developed by Atlantic Research Corp. provides continuous identification of communications channel usage. Called Modulation Mode Identifier (MMI-2), it can distinguish between voice, data and no signal conditions on a communication line. Its uses include selection of the proper test and measurement equipment in automatic test systems and the allocating of communications costs by traffic type as well as line usage. WATS users can make realistic decisions on the use of full-time data circuits as opposed to switched network facilities. *Atlantic Research Corp. Circle 111 on Reader Service Card.*

Speakerphone

An all-new Speakerphone has been introduced by Ford Industries. Designed for installation on any telephone line, with standard telephones, or with key sets, Speakerphone permits its user to talk on the telephone without using the regular handset. It is said to be perfect for normal two-way conversation as well as for group conversations. Manufactured to telephone industry standards, Speakerphone is simple to install, low in cost and attractive in design. Available in charcoal/gray, it utilizes the latest in electronic circuitry methods to achieve high reliability, excellent sound fidelity. *Ford Industries, Inc. Circle 112 on Reader Service Card.*



Microwave multiplex

A microwave multiplex combining and splitting network is available which provides two, three, four, five and six-way combining and splitting functions at a microwave junction, with zero loss between all inputs and outputs.

Various combinations of the KK-1516 combining & splitting networks may be used for either CCITT or non-CCITT systems to provide path separation at junctions of a microwave system. These combining & splitting networks facilitate the branching of voice multiplex channels, data channels, order wire multiplex channels, pilot signals and/or alarm functions. One or more stubs may be accommodated at a given junction and additional combiners and splitters may be added at any time to provide additional combining and splitting capabilities.

The basic units are plug-in hybrid power dividers which perform the com-

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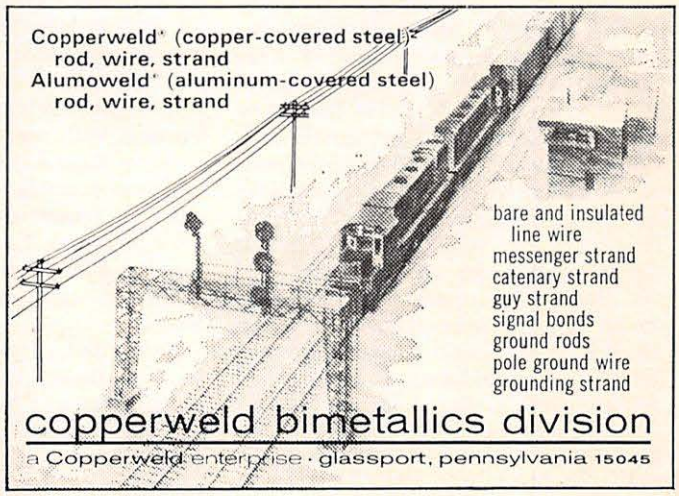

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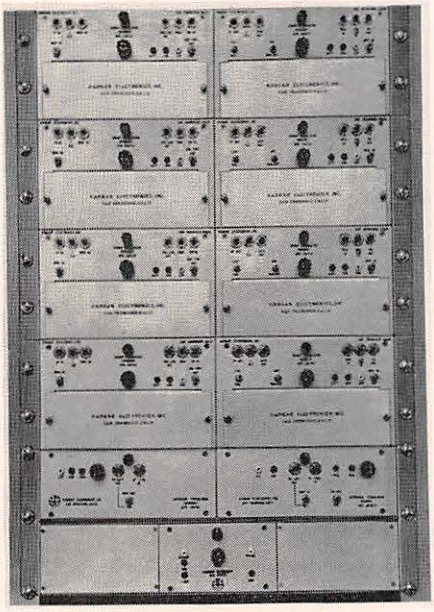
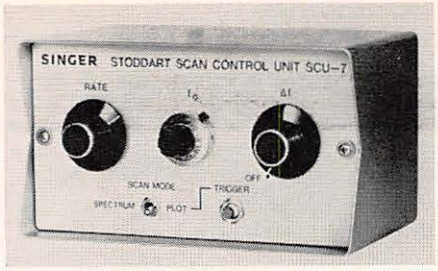
bining/splitting function; one is required for each direction of transmission for each microwave multiplex path. System loss is compensated for by amplifiers which provide gain from 0 to 30 db, adjustable in 0.5 db steps, over the range of 4 kHz to 8 MHz. Maximum power capability of the system is 1800 channels when used with optional wideband redundant amplifiers.
Karkar Electronics. Circle 113 on Reader Service Card.



Baseband translator

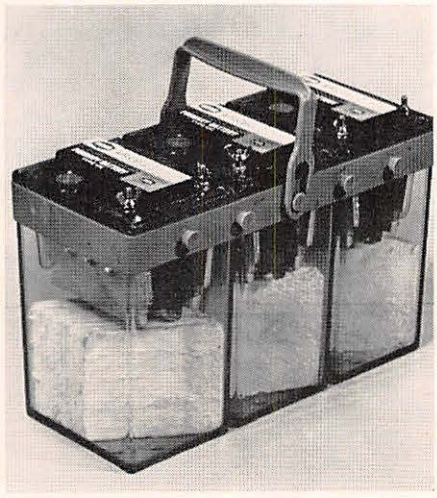
A supervisory baseband translator has been designed to place 300 Hz to 12 KHz signals anyplace in the microwave baseband without the use of Group, Supergroup, or other common equipment. This permits insertion of one to twelve Order Wire Channels or a number of tone channels anyplace in the baseband between 60 KHz and 2540 KHz.

The supervisory baseband translator consists of one to four Group Translators, providing a total of four 12 KHz channels in the 60 to 72, 72 to 84, 84 to 96, and the 96 to 108 KHz frequency range. Four bands of these signals, providing twelve 4 KHz Order Wire Channels are then translated into a 48 KHz slot in the baseband by the Baseband Translator. A self-contained Carrier Generator provides the necessary carrier frequencies used in the two-step modulation/demodulation process. The supervisory baseband translator is capable of accommodating HF input and output levels in the range of −23 to −3 dbm at 135 and 75 ohms.
Karkar Electronics. Circle 114 on Reader Service Card.



Scan unit

A supplementary scan unit gives added scanning capability to field intensity meters models NM-7, NM-17/27 and NM-37/57. Model SCU-7 converts each of these meters to spectrum analyzer operation, when the output is displayed on a regular oscilloscope. Features of the SCU-7 are variable center frequency, variable scan width and variable scan rate. Fast and slow ranges of scan speeds are provided, fast for spectrum display and slow for X-Y plotting. The unit supplies video blanking and pen-lift command.
Singer. Circle 115 on Reader Service Card.

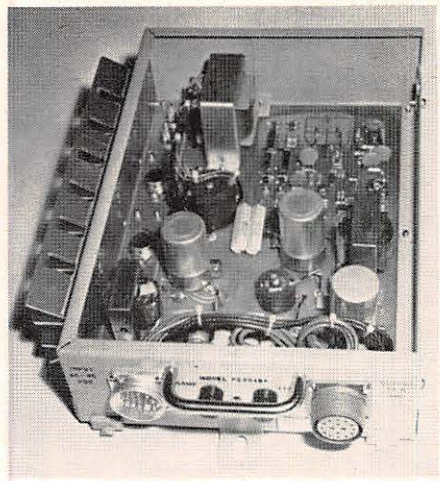


See-through battery

A modular, air-depolarized primary battery with a housing molded of Acrylite MP is now available. Features of this Ucar Type UC battery include the performance advantages of the carbon-zinc-caustic system, and a transparent housing that makes possible a visual check of the exhaustion level.

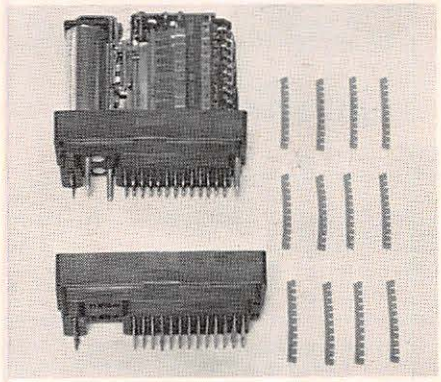
These primary batteries are said to meet all requirements for railroad signal equipment. Each single cell module supplies a nominal voltage of 1.25 and a normal capacity of 1,000 ampere-hours.

Series and/or parallel connections of two or three cell units provide the range of power levels that is essential to railroad signaling. A tough transparent plastic, Acrylite MP has the impact resistance necessary to withstand rough handling and its transparency simplifies visual examination of power level in unusual installations. Ucar Type UC batteries are sold with pure liquid electrolyte already added to minimize installation time and assure adherence to uniform performance standards. *Union Carbide Corp. Circle 116 on Reader Service Card.*



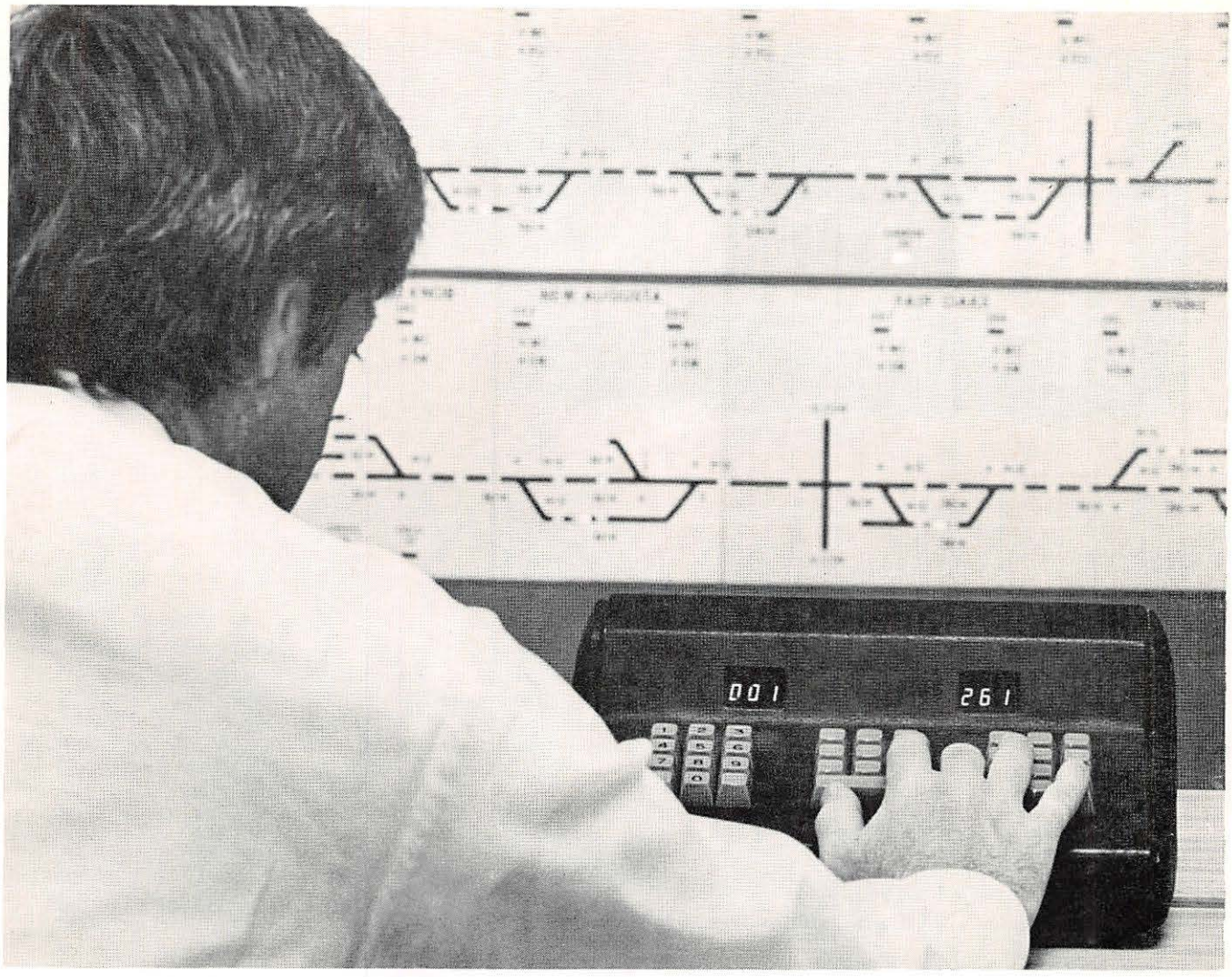
Converter

A DC to DC converter for use on railroad locomotives is available for powering mobile radios. Model 2919A provides 12 volts, 8 amps from 72 VDC to power mobile radios. This approach is said to help reduce cost by allowing the user to specify almost any make of mobile radio. *Glenayre Electronics Ltd. Circle 117 on Reader Service Card.*



Program relay

The manufacturer of a European programmable rotary stepping switch claims mechanical multiple switching is not dead. The 12-step P-69 Program Relay, with twelve in-line microswitches, is said to perform many multiple switching functions more efficiently, reliably and at less overall cost, than is practical with present state-of-the-art solid state switching techniques. P-69 fills a gap between complex gating and solid state circuitry. *Knobel. Circle 118 on Reader Service Card.*



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We call it design flexibility. We'll analyze your present control system; probably a mixture of equipment. Then we'll custom design, fabricate and install a modern, efficient system using your existing telemetry. We won't change your operation for the sake of change. We'll just adapt, consolidate and improve it.

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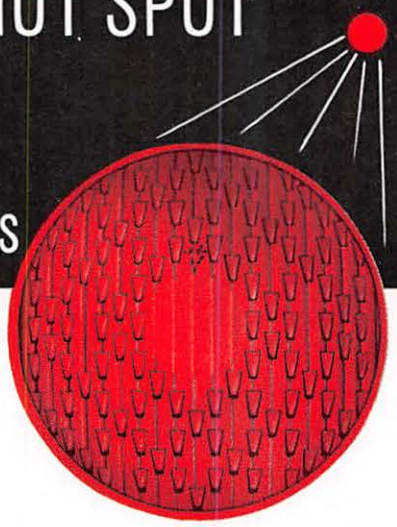
for highway crossing signals



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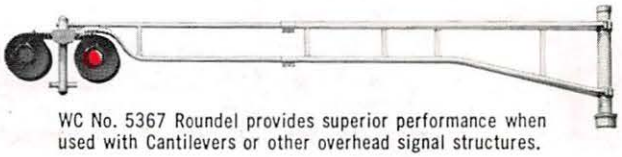
- **Produce a dramatic increase in brightness**
- **Provide maximum efficiency in light distribution and control**
- **Resist damage from vandals**
- **Meet applicable A.A.R. standards**

Unique characteristics provide precise optical control of light distribution. Less light is wasted. Prisms in the roundel are designed to direct light for maximum effectiveness, even under most adverse weather conditions.

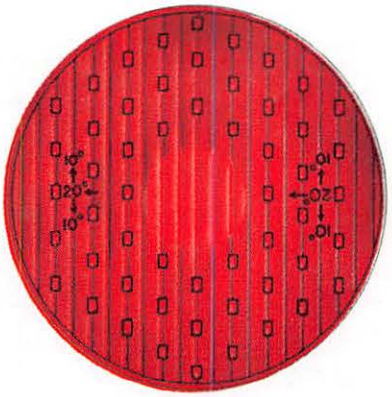
High-impact polycarbonate plastic used in 8⅜" diameter lens surpasses glass, butyrate and acrylic plastic in impact resistance. Special inhibitors in the plastic protect the roundel from deterioration from ultraviolet light. Color, uniformly distributed throughout the roundel, conforms to A.A.R. Signal Section 136, Highway Crossing Red. Easily installed in any standard crossing signal light. Write for Bulletin 1-14A.

** Comparison tests of peak candle power at 1000 feet performed by leading independent light testing laboratory. Test details upon request.*

WC No. 5367, 20° H x 32° V Long Range, High Intensity Hot Spot Roundel. Designed for use on cantilevers and signal bridges. Horizontal spread is 20°; Vertical deflection is 32° downward. The Hot Spot is 2" in diameter. Optimum brightness is assured from 25 feet to 1,000 feet, in advance of the signal. Independent tests* show 120% improvement over other styles of roundels.



WC No. 5367 Roundel provides superior performance when used with Cantilevers or other overhead signal structures.



WC No. 5357, 20° H (15°-5°), 10° V Long Range, High Intensity Hot Spot Roundel. Especially suited for roadside signals. Vertical spread is 10° at 0° Horizontal, increasing to 20° Vertical Spread at 15° Horizontal toward the traffic side. The horizontal deflection is 20° (15° to the traffic side of the signal and 5° to the field) providing maximum brightness in the traffic lane. The Hot Spot is 2" in diameter. Symmetric design allows the roundel to be rotated 180° for signals located to the left of traffic with the same outstanding results.

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